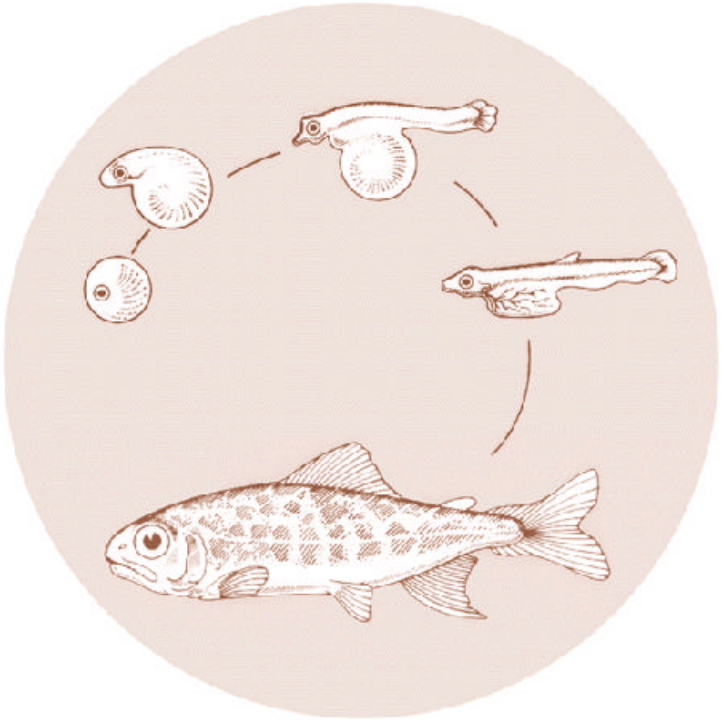
July 2001

UMATILLA HATCHERY MONITORING AND EVALUATION (NOVEMBER 1, 1998 - OCTOBER 31, 1999)

Annual Report 1999



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UMATILLA HATCHERY MONITORING AND EVALUATION

ANNUAL REPORT 1999
(NOVEMBER 1, 1998 - OCTOBER 31, 1999)

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EXECUTIVE SUMMARY

This report summarizes monitoring and evaluation studies of salmonids reared at Umatilla Fish Hatchery (UFH) for 1 November, 1998 to 31 October, 1999. Studies at Umatilla Hatchery are designed to evaluate rearing of chinook salmon and steelhead in "Michigan raceways". Characteristics of Michigan raceways include high fish densities, rapid water turnover, oxygen supplementation, reuse of water, and baffles designed to reduce cleaning. Fish health at UFH and other facilities associated with the Umatilla program are intensively monitored and evaluated along with the overall research project. Further, under the Integrated Hatchery Operations Team guidelines, specific requirements for fish health monitoring at UFH are mandatory. Additional studies include evaluations of sport fisheries in the Umatilla River and mass marking and straying of fall chinook salmon. Except for adult recovery data, an experiment designed to evaluate rearing subyearling fall chinook salmon in Michigan and Oregon raceways has been completed. We are currently in the third year of rearing subyearling fall chinook salmon at three densities and continued rearing of subyearling, fall release, and yearling spring chinook salmon, and steelhead. Although preliminary adult return data has been recovered, data on smolt-to-adult survival for all groups is incomplete. Conclusions in this report should be viewed as preliminary and subject to change as additional data becomes available.

Objectives for Fiscal Year 1999

Hatchery Monitoring and Evaluation

1. Document egg-take, egg-to-fry, and egg-to-smolt survival for salmon and steelhead reared at UFH and released in the Umatilla River.

2. Document rearing density, loading, and cost of salmon and steelhead reared at UFH. Document rearing density and loading for salmon and steelhead reared at Bonneville, Carson, and Little White Salmon hatcheries and released in the Umatilla River.

3. Document number, size, time, and release location for salmon and steelhead reared at Umatilla, Bonneville, Carson, and Little White Salmon hatcheries and released in the Umatilla River.

4. Collect and compare monthly length, weight, and condition factor estimates for salmon or steelhead reared in Michigan and Oregon raceways at UFH.

5. Calculate growth for salmon and steelhead reared in Michigan and Oregon raceways at UFH.

6. Determine length, weight, condition index, smolt status, descaling, and fin condition at pre-release or release for salmon and steelhead reared at Umatilla, Bonneville, Carson, and Little White Salmon hatcheries and released in the Umatilla River.

7. Evaluate smolt migration performance of PIT-tagged salmon or steelhead reared at Umatilla, Bonneville, Carson, and Little White Salmon hatcheries, released in the Umatilla River and recovered at John Day and Bonneville dams.

8. Evaluate smolt-to-adult survival (SAS) of salmon and steelhead by coded-wire-tagging.

9. Summarize catch and escapement and life history data from coded-wire-tagged salmon and steelhead released in the Umatilla River.

10. Evaluate straying of adult fall chinook salmon produced from hatchery releases in the Umatilla River.

11. Estimate the sport harvest of salmon and steelhead in the Umatilla River with creel survey methods.

12. Participate in production and management planning activities for anadromous fish in the Umatilla River basin.

13. Evaluate steelhead smolt migration in the Umatilla River with radiotelemetry.

Fish Health Monitoring and Evaluation

1. Conduct monthly fish health examinations on five fresh-dead or moribund juvenile fish from index raceways of each species and stock reared at Umatilla Hatchery.

2. Conduct monthly fish health examinations on five grab-sampled juvenile fish from the lower raceway of each chinook salmon series at Umatilla Hatchery.

3. Conduct preliberation fish health examinations on 30 grab-sampled yearling chinook salmon per evaluation raceway at Umatilla Hatchery four weeks prior to release.

4. Conduct preliberation fish health examinations on ten grab-sampled yearling steelhead per raceway at Umatilla Hatchery four weeks prior to release.

5. Develop disease profiles of fish reared under differing conditions and make comparisons among rearing strategies.

6. Examine fish when unusual loss or behavior occurs using appropriate diagnostic methods. Implement therapeutic or prophylactic measures to control, moderate, or prevent disease outbreaks.

7. Continue implementation of Federal Drug Administration Investigational New Animal Drug protocols, including prophylactic feeding of Aquamycin to spring chinook salmon juveniles at Umatilla Hatchery.

8. Continue implementation of prophylactic and therapeutic treatments, either under Federal Drug Administration Investigational New Animal Drug protocols or prescriptions for oxytetracycline,erythromycin, formalin, and Chloramine-T, as needed for disease treatments of all species, ages, and stocks at Umatilla Hatchery, Minthorn Ponds, South Fork Walla Walla adult facility, and Three Mile Dam adult facility.

9. Examine fish at Thornhollow and Imeques C-mem-ini-kem acclimation facilities during periods of increased loss or for preliberation following transfer from Umatilla Hatchery, Little White Salmon NFH, and Willard NFH.

10. Collect BKD (*Renibacterium salmoninarum)* ELISA data from all chinook and culturable virus data from up to twenty spawned females, per spawning date, per species providing eggs for Umatilla Hatchery.

11. Analyze data from broodstock sampling to anticipate potential disease problems in progeny and develop subsequent control recommendations or possible treatments.

12. Continue to develop expertise in statistical analysis pertinent to the epidemiological evaluations at Umatilla Hatchery. Use this to analyze trends in all data accumulated to date.

13. Monitor coded-wire tag spring chinook salmon adults, which originated from juveniles reared at Umatilla and Bonneville Hatcheries and returned to the Umatilla River for *Renibacterium salmoninarum.*

Accomplishments and Findings for Fiscal Year 1999

Hatchery Monitoring and Evaluation

We achieved all of our objectives in fiscal year 1999. Downstream smolt migration was monitored with radiotelemetry for the first time and PIT-tagging for the second time in 1999.

Fall Chinook Salmon

Subyearlings, Rearing in Michigan and Oregon Raceways: The SAS of the 1991-93 broods was less than 0.01%. Small sample sizes may limit statistical comparisons; however, preliminary analysis suggests similar survival rates for fish reared in Michigan (MI) and Oregon (OR) raceways and among groups reared in first, second, or third pass Michigan raceways.

Subyearlings, Density Studies in Michigan Raceways: Subyearlings were reared at three densities for the third year in 1998-99. Approximately 1.8 million subyearling fall chinook salmon were reared in Michigan raceways and released in the Umatilla River. Production did not exceed the 2000 fiscal year goal (2.6M) and the fish were bigger than the size goal of 60 fish/lb. Cumulative densities in three Michigan raceways produced 427, 651, and 865 fish/gpm in low, medium, and high density series. Combined rearing and marking costs were $0.18/smolt. All fish were coded or blank wire-tagged in 1999 with >96% retention. We PIT-tagged approximately 600 fish from each raceway to monitor juvenile migration. The number of PIT-tagged fish recovered at John Day (JD) Dam ranged from 45-69 fish for each group with recovery of 8.0-11.9%. Smolts required an average of 18-21 days to reach JD Dam. Larger fish at tagging were detected at a higher rate. No differences in travel time were observed for fish reared at different densities.

Yearlings (Bonneville Hatchery/Willard Hatchery): Approximately 450 thousand yearlings (1997 brood) were reared at Bonneville Fish Hatchery (BFH) and released in the Umatilla River. Production was below the 1999 fiscal year goal (480K) but the release weight of 9.3 fish/lb was larger than the 10.0 fish/lb goal. All yearlings were coded or blank wire-tagged (>97% retention). Juvenile migration was monitored by PIT-tagging 484 fish from two releases. The first release had 27 PIT-tagged fish (10.9%) and 6 (2.4%) detected at JD and Bonneville (BN) dams while the second release had 6 (2.4%) and 14 (5.9%) detected. Adult survival of fish reared at BFH and released in the Umatilla River ranged from 0.00-0.04% for the 1990-91 broods.

Adult Returns to the Umatilla River: Counts of fall chinook salmon at Three Mile Falls Dam (TMFD) in 1998 were 354 adults, 207 jacks, and 189 subjacks. Adult returns peaked in early-October. Based on CWT recoveries, both subyearling and yearling releases contributed to adult returns, but all subjacks originated from yearling releases.

Fishery: Anglers totaled 549 and fished 3,299 h for fall chinook and coho salmon in 1998. Fall chinook salmon jack and adult catch rates were 0.03 and 0.01 fish/h and anglers harvested 84 jack and 3 adult fall chinook salmon. Catch rates for coho salmon averaged 0.03 fish/h and 0.02 fish/h for jacks and adults. Anglers harvested 33 jack and 56 adult coho salmon.

Straying: Wire-tagged fish from Umatilla releases were removed at Lower Granite Dam. We estimated that 14 subyearling and 3 yearling 1999 releases will escape past Lower Granite Dam between 2000-03.

Spring Chinook Salmon

Subyearlings: No subyearling spring chinook salmon were reared at UFH in 1998-99. Previous releases have been unsuccessful. Only one coded-wire-tagged fish has been recovered from subyearlings released from 1992-94.

Fall Release: No fish were reared for fall release in 1999. Few CWT's have been recovered from releases made from 1992-94. Survival rates for the 1991 brood reared at UFH were 0.00-0.01%. Preliminary survival estimates of the 1992-93 broods reared at UFH ranged from 0.00-0.08%. Moreover, current survival rates for the 1993 brood are greater than survival rates for spring release yearlings.

Yearlings:

Umatilla Hatchery: Approximately 369 thousand yearling spring chinook salmon were reared at UFH in three MI and two OR raceways and released in the Umatilla River in 1999. Fish from two OR raceways were released in the fall. This was greater than the 1999 fiscal year goal (360K). Fish were released at 12.8-18.1 fish/lb, smaller than the 15 fish/lb goal. Rearing and marking costs were $0.25/smolt. Approximately 151 thousand fish were coded-wire-tagged for release (> 99% retention). Juvenile migration was monitored by PIT-tagging 240 fish each from each MI and OR raceway. Fish from MI and OR raceways had ranges of 25-37 fish (10.4-15.9%) and 9-17 (3.8-7.3%) detected at JD and BN dams while the OR raceway fish released in the fall had 8-10 (3.3-4.1%) and 2-3 (0.8-1.3%) detected. The median travel time for both MI and OR fish to JD and BN Dams was 45and 49 days. Total SAS of yearlings reared at UFH has been poor. Through 1999, SAS for 1991-94 broods have ranged from 0.003-0.06%.

Little White Salmon Hatchery: The goal to rear 350 thousand yearlings at Little White Salmon Hatchery for release in the Umatilla River was met in 1999. Juvenile migration was monitored by PIT-tagging 467 fish from two releases. They were released in March at 16.1 fish/lb and April at 12.7 fish/lb, smaller than the release goal of 12 fish/lb. Relative survivals of PIT-tagged fish were 3 and 10% for the March and April releases. The first release had 21 (8.5%) and 9 (3.6%) fish detected at JD and BN dams while the second release had 32 (14.7%) and 12 (5.5%) fish detected. No adult survival data was available.

Carson Hatchery: The goal to rear 100,000 yearlings at Carson Hatchery for release in the Umatilla River was met in 1999. Release size of 13.2 fish/lb, exceeded the 15 fish/lb goal. Juvenile migration was monitored by PIT-tagging 248 fish. The release had 45 (18.1%) and 13 (5.2%) fish detected at JD and BN dams. No adult survival data was available.

Adult Returns to the Umatilla River: We predicted an adult run of 731 adult spring chinook salmon to the Umatilla River; actual run size was 1,768 adults and 210 jacks in 1999. Adult returns peaked in mid-May and analysis of CWT data indicated the majority of returning adults were from the 1993 brood reared at BFH.

Fishery: The sport fishery for spring chinook salmon was open 29 May through 20 June. No fish were harvested between Three Mile Falls Dam and Yoakum Bridge and 6 (expanded) were harvested from the river above the Yoakum Bridge to the Confederated Tribes of the Umatilla Indian Reservation border.

Summer Steelhead

Juvenile Rearing and Survival: Approximately 123 thousand steelhead were released in 1999. Steelhead production was lower than the 1999 fiscal year goal (150,000). The size-at-release ranged from 4.9-5.9 fish/lb and fish from two of three raceways were smaller than the 5 fish/lb goal. Combined rearing and marking costs were $0.67/fish. Approximately 60,000 fish were CWT in 1998-99 (>93% retention) and all fish were adipose fin-clipped. Juvenile migration was monitored by PIT tagging approximately 250 fish from each raceway. First-time detections for all interrogation sites (minimum survival to TMFD) was 36% for the large-grade fish released from Minthorn acclimation facility (MN) and ranged from 16-17% for small-grade and large-grade fish released from Bonifer Springs acclimation site (BS). Migration duration past JD and BN dams was from 18 April – 21 June with the greatest number of detection in the last week of May and first week of June.

Adult Survival: Coded-wire tag data continues to indicate a greater SAS for large-grade steelhead released in April than for the small-grade fish released in May. For brood years 1992-1994, mean SAR of large-grade steelhead released at MN and BS was 0.57% and 0.77%, respectively, and 0.13% for small-grade steelhead released at BS.

Adult Returns to the Umatilla River: Number of steelhead counted at TMFD in 1998-99 was 751 hatchery fish and 1,135 natural fish (total count = 1,886 fish). Total run was estimated at 1,940 (includes 54 hatchery steelhead harvested between Umatilla River mouth and TMFD). Since 1993, run timing of hatchery and natural steelhead has remained similar, and mean proportions of one- and two-ocean fish were nearly identical for hatchery and natural fish (60% one ocean). However, mean percentage of males in the run has been significantly higher for hatchery fish (42%) than natural fish (29%). Of 86 fish sampled for CWT's at TMFD, 4 were out of system stray hatchery steelhead and by expansion we estimated that 3.6% (67 of 1,886) of the total Umatilla run were stray hatchery fish. Stray fish have been recovered at TMFD primarily in October and November these past to years.

Fishery: We estimated 1,341 anglers fished 8,805 h in 1998-99. This is the highest effort since creel surveys began in 1992-93. Increased effort was probably due to recent increases in the local population, mild weather, and relatively stable river flows. In the lower river 549 anglers fished 3,299 h and harvested 54 (±27) fish for a catch rate of 22 h/fish. In the upper river 792 anglers fished 5,506 h and harvested 47 (±31) fish for a catch rate of 24 h/fish. Anglers harvested 13.7% of the hatchery steelhead run and caught and released 22.0% of the natural steelhead run this year. Since run year 1993-94, harvest has averaged 8.6% of the hatchery steelhead run and catch and release of natural steelhead has averaged 17.0%.

Fish Health Monitoring and Evaluation

Broodstock Monitoring

A first time isolation of infectious hematopoietic necrosis virus (IHNV) was made in the 99 brood year (BY) Umatilla River spring chinook spawned at South Fork Walla adult facility. Twenty-nine of 69 (42.0%) females sampled were positive for IHNV. Infectious hematopoietic necrosis virus (IHNV) was also isolated from 3/41 (7.3%) BY99 Umatilla River summer steelhead female spawners at Minthorn Ponds.

The BY98 fall chinook salmon adults spawned at Three Mile Dam adult facility and Priest Rapids were negative for culturable viruses.

There were no cases of clinical bacterial kidney disease (BKD) in the BY98 Umatilla River fall chinook salmon or BY99 spring chinook salmon. Enzyme-linked immunosorbent assay (ELISA) results for *Renibacterium salmoninarum* (Rs) antigen in both stocks revealed only negative or low levels.

The bacterial pathogens *Aeromonas salmonicida*, the causative agent of furunculosis, and *Flavobacterium psychrophilum*, the causative agent of cold water disease (CWD) were detected in 3/10 (30%) BY98 Umatilla River fall chinook mortalities.

Juvenile Monitoring

There were no cases of bacterial kidney disease (BKD) in any fish reared at Umatilla Hatchery. ELISA monitoring for Rs antigen in 98 brood year Priest Rapids fall chinook and 97 brood year Umatilla River spring chinook did not reveal any evidence of an Rs infection problem at any lifestage prior to release.

Flavobacterium psychrophilum (CWD bacterium) was occasionally isolated from the 98 brood year summer steelhead, fall chinook sub-yearlings and 97 brood year spring chinook at Umatilla Hatchery.

All juvenile examinations for culturable viruses at Umatilla Hatchery were negative.

The 98 brood year Priest Rapids fall chinook programmed as sub-yearlings experienced increased loss soon after ponding which was attributed to coagulated yolk disease and tail fungus.

Preliberation monitoring of the 98 brood year Priest Rapids fall chinook sub-yearlings at Imeques C-mem-ini-kem acclimation ponds revealed that 10/18 (55.5%) moribund/fresh-dead fish had moderate to high levels of *Yersinia ruckeri* (Enteric Redmouth) bacteria.

One case of bacterial kidney disease (BKD) was discovered during preliberation monitoring of the 97 brood year Carson spring chinook at the Imeques C-mem-ini-kem acclimation ponds.

Preliberation/increased-loss examinations of 97 brood year fall chinook salmon at Thornhollow acclimation ponds revealed a high prevalence (70%) of BKD and CWD bacteria (60%) in mortalities.

Prophylactic Treatments

The 97 brood year Umatilla River spring chinook salmon were given two erythromycin (Aquamycin) medicated feedings. Non-lethal and low level lethal signs of toxicity were observed during toxicity testing.

Management Implications and Recommendations

Hatchery Monitoring and Evaluation

1. Preliminary estimates of SAS for subyearling fall chinook salmon reared in MI and OR raceways and in different MI passes are similar. However, adult survival has been poor and the number of CWT's recovered may not be adequate (required N=35) to perform statistical tests.

2. Juvenile performance from the 1996-98 broods suggests rearing subyearling fall chinook salmon at high densities is successful. The high density MI series (400 K) produces 33% more fish (1.2 M) than the standard MI series (0.9 M) and at a survival rate of 0.30% would produce 900 more adults. Moreover, the rearing environment, fish quality, and smolt migration of subyearlings reared at three densities appears to be similar.

3. Determining the outmigration success of subyearling fall chinook salmon to accurately assess whether poor SAS is related to fish quality or environmental conditions in the migration corridor is critical. Percent detection of PIT-tagged fish at JD dam averaged 5.1-5.8% for all groups but was greater for fish that were larger at tagging. We recommend conducting studies to determine the optimum size, time, and location to release juveniles.

5. Recent SAS of fall chinook salmon released as yearlings is poor. Moreover, the current rearing and release strategies produces a high proportion of males returning as age 2 minijacks. The number of smolts lost for adult production because of early maturation should be determined. Rearing and release experiments designed to reduce the production of subjacks and improve SAS should be considered if production becomes a significant loss.

6. Fall chinook salmon straying remains a concern and constitutes a loss of escapement to the Umatilla River and a risk to the Snake River population. If added to the Umatilla returns, strays to the Snake River would have increased the return to the Umatilla River by 20%.

7. Data continues to indicate greater SAS for spring chinook salmon yearlings reared at BFH. However, recent changes in the rearing profile have produced a smolt that is smaller and similar to smolts reared at BFH. We recommend incubating eggs at lower temperatures throughout embryo development to produce smaller smolts at release.

8. Oxygen-supplemented MI raceways have performed well by most measures of juvenile steelhead rearing performance since densities were reduced from about 6 lb/ft^3 to 4 lb/ft^3 following the initial 1991 brood. Lowering the rearing density significantly reduced the water-use efficiency advantage of MI raceways over OR raceways from an estimated 100 to 30% (based on gallons/smolt). However, water-use efficiency must ultimately be measured by gallons/adult in a side-by-side evaluation of MI and OR rearing systems. This test is one of the highest evaluation priorities listed in the UFH master plan and should be conducted in the future if fish production needs and water supply allow. If the opportunity to conduct this test arises, we recommend adding a fourth pass to

the MI system to bring it's water-use efficiency advantage back up to 100% more than OR systems. Adding a fourth pass might also be considered if our steelhead production goals increase in the future.

9. The contribution of small-grade steelhead to our adult return goals has been low. Survival of large-grade steelhead from brood years 1992-94 has averaged 0.67% compared to 0.13% for graded smalls. PIT tag and radio-telemetry data suggests these SAS differences are a result of a lack of juvenile migration and/or poor freshwater survival for the small steelhead compared to larges. We recommend acclimating the small group lower in the river (Minthorn) where they can be released into the mainstem. The current release site (Bonifer Pond, Meacham Creek) introduces them into a tributary stream which may encourage residency. This release strategy should be continued a minimum of four years to provide adequate SAS data.

10. Rearing methods for small grade steelhead should be reevaluated to identify fish culture strategies that could improve SAS. The graded smalls produce few adults in relation to rearing time and effort spent. Possible options include changing feed to increase growth rates or rearing them in an Oregon series at low density.

11. Current information suggests our SAS goal for hatchery steelhead and related supplementation goal are too high. To date, SAS has averaged less than <20% of the original goal of 2.7%. Managers will be reevaluating this goal soon in conjunction with development of new management plans.

12. Our creel survey likely underestimated steelhead catch and harvest and should be viewed as an index for documenting long term trends. Harvest estimated from punch-card data has been two to five times higher than creel estimates, but probably overestimate harvest. Seventy-four percent of the river open to sport angling above TMFD is not surveyed because of limited access. We have attempted surveying these access areas in the past and have documented low effort and success. However, we have received several reports of exceptional catch rates by boaters and private landowners in the unsurveyed area. Reconnaissance aerial surveys at key times should be considered to more accurately estimate the amount and distribution of angling effort in the unsurveyed river. This information would be useful for evaluating whether survey methods could be developed for this area.

Fish Health Monitoring and Evaluation

1. Continue sampling 100% of the female adult chinook salmon for Rs to allow for the culling of eggs and/or implementing segregated rearing strategies if needed. This will continue to help reduce the impact of bacterial kidney disease (BKD) on restoration efforts.

2. Seek ways to maximize the benefit of erythromycin (Aquamycin) medicated feeding while reducing the toxic effects. It may be possible to reduce the number of Aquamycin medicated feedings to one since Umatilla River spring chinook salmon spawned at South Fork Walla adult facility have shown a low prevalence of BKD.

3. Continue efforts to sample 100% of coded-wire tagged returning adult chinook salmon in order to obtain more samples for comparison of Rs infection levels based on rearing strategy and hatchery of origin.

4. Implement prophylactic injections of oxytetracycline (OTC) to fall chinook salmon at Three Mile Dam adult facility in future years to reduce the infection rate and the pre-spawning mortality due to furunculosis. Prophylaxis should be given as intraperitoneal injections of OTC at a dosage of 10 mg per Kg of fish body weight. This injection should be administered when the fish are sorted into the holding ponds.

5. Implement and maintain rearing strategies that seek to reduce stress and evaluate the effects of potential stress reducing rearing strategies.

6. Minimize or eliminate the practice of stocking fish into the Umatilla basin known to have significant prevalences of serious salmonid fish pathogens to minimize the impact on natural or other hatchery-produced fish.

REPORT A

Umatilla Hatchery Monitoring and Evaluation

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OREGON DEPARTMENT OF FISH AND WILDLIFE

INTRODUCTION

The Northwest Power Planning Council's Columbia River Basin Fish and Wildlife Program authorized construction of Umatilla Fish Hatchery (UFH) in 1986. Measure 703 of the program amended the original authorization for the hatchery and specified evaluation of the Michigan (MI) raceways using oxygen supplementation to reach production goals of 290,000 lb of chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*O. mykiss*). The hatchery was completed in fall 1991. Partial justification for the hatchery was to evaluate new production and supplementation techniques. MI raceways at UFH increase smolt production with a limited water supply. Test results for MI raceways will have systematic application in the Columbia River basin.

The UFH is the foundation for rehabilitating chinook salmon and enhancing steelhead in the Umatilla River (CTUIR and ODFW 1990) and is expected to contribute significantly to the Northwest Power Planning Council's goal of doubling salmon production in the Columbia Basin. Hatchery production goals and a comprehensive monitoring and evaluation plan were presented in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990). The Comprehensive Plan for Monitoring and Evaluation of Umatilla Hatchery (Carmichael 1990) was approved by the Northwest Power Planning Council as a critical adaptive management guide for fisheries rehabilitation in the Umatilla River. Monitoring and evaluation will be used to increase knowledge about uncertainties inherent in the fisheries rehabilitation and will complement the developing systematic monitoring and evaluation program.

The monitoring and evaluation goals are:

1. Provide information and recommendations for the culture and release of hatchery fish, harvest regulations, and natural escapement to accomplish long-term natural and hatchery production goals in the Umatilla River basin that are consistent with provisions of the Council's Columbia River Basin Fish and Wildlife Program.

2. Assess the success of achieving the management objectives in the Umatilla River basin that are presented in the Master Plan and the Comprehensive Rehabilitation Plan.

A substantial proportion of the production at UFH is reared in MI raceways. This system has not been thoroughly evaluated to determine the effects on Smolt-to-adult survival (SAS). In addition, the rearing strategies proposed for spring chinook salmon require an unusually extensive period of incubation in chilled well water.

Extensive background and justification for UFH monitoring and evaluation is presented in Carmichael (1990). In this report, we present findings for the UFH Monitoring and Evaluation Project from 1 November 1998 to 31 October 1999. We designed our program to evaluate fish cultural practices, conduct rearing and survival studies, assess sport fisheries, and provide information for planning and coordination. Additional studies have been designed for fall chinook salmon to evaluate straying and the effects of tagging.

We monitored the culture and performance of more than 3.2 million chinook salmon and steelhead produced at UFH in 1997-98 (Appendix Tables A1-8). Individual stock profiles, release, performance, and return data of previously released groups are presented in the following sections.

STUDY SITE

The UFH is located approximately seven miles west of the town of Irrigon, Oregon. It is operated under a cooperative agreement among the Oregon Department of Fish and Wildlife (ODFW), the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), the Bonneville Power Administration, the U.S. Fish and Wildlife Service, and the U.S. Army Corps of Engineers.

The hatchery was designed to produce salmonids in oxygen supplemented MI raceways and in non-oxygen supplemented Oregon (OR) raceways. Detailed UFH information is available in the Umatilla Hatchery Master Plan (CTUIR and ODFW 1990) and in the Environmental Assessment Report (BPA 1987). The MI system consists of eight series of three concrete raceways. Water flows from the upper raceway to the middle raceway and then to the lower raceway within each series. Before the water enters each raceway, pure oxygen is supplemented through an oxygen contact column. More detailed descriptions of the raceways are presented in Focher et al. (1998).

The Umatilla River and tributaries are located in Umatilla, Morrow, and Union counties, Oregon. Broodstock facilities for fall chinook and coho salmon, spring chinook salmon, and steelhead are located at Three Mile Falls Dam (TMFD), South Fork Walla-Walla River, and Minthorn Springs (MS). Acclimation facilities include MS at river mile 64.5, Thornhollow (TH) at river mile 73.5, Imeques C-mem-ini-kem (IC) at river mile 80, and Bonifer Springs (BS) at river mile 2 of Meacham Creek (Figure 1).

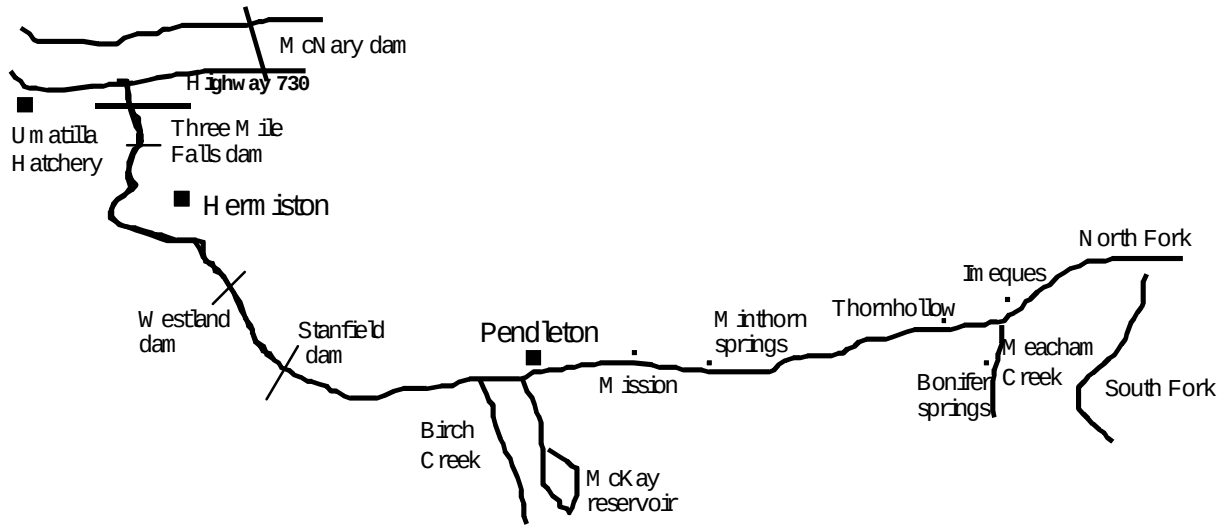

Figure 1. Map of the Umatilla River showing locations discussed in text.

FALL CHINOOK SALMON

Overview

Subyearling fall chinook salmon have been reared in MI or OR raceways at UFH and released in the Umatilla River starting with the 1991 brood (Appendix Table A-2). Adult return data is needed to complete an evaluation of rearing subyearlings in MI and OR raceways (1991-95 broods). The 1996-98 broods were reared at three densities in Michigan raceways to evaluate rearing success, juvenile performance, and SAS. Yearlings have also been reared at UFH, Bonneville Hatchery (BFH), and Willard National Fish Hatchery (WNFH) and released in the Umatilla River (Appendix Table A-3) as additional production strategy. There are no formal yearling experiments, but all releases are monitored. All studies are still in progress.

Methods

Subyearlings

Juvenile Rearing and Migration Performance Studies: Methods to monitor water quality, juvenile rearing and migration, and hatchery operation and costs at UFH were described in 1992-98 annual reports (Keefe et al. 1993, 1994; Hayes et al. 1996a, 1996b, Focher et al. 1998, Hayes et al. 1999). PIT tag methods were the same as described in the 1998 annual report (Hayes et al. 1999) except that fish were not photonic-marked and 600 fish were tagged from each group.

Adult Survival Studies: Methods to determine SAS were described in the 1992-98 annual reports. Coded-wire tag data was downloaded from Pacific States Marine Fisheries Commission (PSMFC) database in January 2000.

Yearlings

Juvenile Rearing and Migration Performance Studies: Methods to monitor rearing and survival were the same as described for subyearlings with the following exception. To study juvenile migration and survival, we collected fish from liberation trucks at the acclimation sites and PIT-tagged approximately 300 fish from each raceway containing coded-wire-tagged (CWT) fish for BFH and WNFH releases.

Adult Survival Studies: Methods to determine SAS were the same as described for subyearlings.

Adult Returns to the Umatilla River

Methods to analyze adult return data were described in the 1998 annual report.

Fishery

Except for the following modifications, fall chinook and coho salmon sport fisheries were surveyed as described in the 1993-98 annual reports. The fall chinook and coho salmon sport fishery was open from 1 September to 30 November 1998. Fishing was allowed from the Highway 730 bridge in Umatilla up to Stanfield Dam (RM 32.5). However, adult chinook salmon could not be harvested above Highway 730. Anglers were allowed to harvest 2 adult coho salmon per day and 5 coho (<20 in) or chinook (<24 in) jacks per day. We did not survey between TMFD and Stanfield Dam because little effort was

observed here in 1998. The percent of the run harvested was calculated by dividing number harvested by the fish count at TMFD plus the estimated harvest below TMFD times 100.

Straying

Fall chinook salmon straying to Lower Granite Dam in the Snake River was estimated by the Washington Department of Fish and Wildlife (G. Mendel, Washington Department of Fish and Wildlife, personal communication). Methods used to estimate future strays were described in previous annual reports.

Statistical Analyses

Statistical methods used were the same as described in previous annual reports. Significance level was $p \leq 0.05$ for all test.

Results

Subyearlings, Rearing in Michigan and Oregon Raceways

Overview: Five broods of subyearling fall chinook salmon (1991-95) were reared in MI and OR raceways at UFH and released in the Umatilla River (Appendix Table A-2). The objectives of this study are to compare juvenile rearing and migration performance and SAS between subyearlings produced in MI and OR systems and among groups reared in different MI passes at the design densities.

Juvenile Rearing and Migration Performance Studies: Juvenile rearing and migration data was presented in previous annual reports.

Adult Survival Studies: Estimates of adult production, SAS, and recovery location are presented in Tables 1 and 2. Survival data is complete for the 1991-93 broods.

Subyearlings, Density Studies in Michigan Raceways

Overview: Three broods of subyearlings (1996-98) have been reared at three densities in MI raceways. The objectives of this study are to compare juvenile rearing and adult survival for subyearlings reared at densities of 200,000, 300,000, and 400,000 fish per raceway. This experiment will be continued four years ending with BY 1999.

Juvenile Rearing and Survival Studies: Juvenile rearing, release, and survival data are presented in Tables 3-4 and Appendix Tables A1-A2. Subyearlings (1998 brood) were ponded outside in four OR raceways on 17 February 1999. These groups were split into six MI raceways from 29-30 March. Because of an egg shortage, less than 2 million fish were reared; therefore, only first and second pass raceways were used. Fish were marked with adipose clipped (AD) + CWT or not clipped + blank-wire-tagged (BWT) during April.

Food conversion ratios (lbs feed/lbs growth after final splits into MI raceways averaged 1.29, 1.07, and 1.08 for 200, 300, and 400 K densities. Food conversion for all raceways combined was 1.15. Based on the production of 29,872 pounds; total cost including tagging (CWT and BWT) was $0.18 per fish.

Length, weight, and condition factor data before acclimation, prerelease, and release is presented in Tables 5-8. Statistical analysis showed no density, pass, or density by pass interaction effects. Analysis

did show a significant brood year effect and weight and condition factor were lower for the 1997 brood. Most subyearlings (86.1-99.5%) were classified as intermediate smolts. Smolts and parr ranged from 0.0-8.5% and 0.0-10.9%, respectively. Little erosion of the dorsal, caudal, or paired fins was observed. Fish with split caudal fins ranged from 3-21% and fish with split dorsal fins ranged from 0-4%.

Tagging, release and recovery data of PIT-tagged fish is presented in Tables 9-11 and Appendix Table A-2 and A-9. Coded-wire tag retention ranged from 96.2-100.0%. Subyearlings were transferred to acclimation ponds from 12-14 May and released on 3 June. PIT-tagged juveniles were detected at John Day (JD) Dam from 10 June- 27 July, and at Bonneville (BN) Dam from 11 June – 26 July. All density groups were similarly detected at JD or BN dams. Fish that were larger at tagging tended to be detected more (Table 11).

Adult survival Studies: The first adult returns are expected in 1999.

Yearlings

Overview: Two broods (1994-95) of yearlings have been reared in MI and OR raceways at UFH and released in the Umatilla River. Yearling production at UFH may continue when space is available; however, propagation of spring chinook salmon is a priority. The size at release goals are 8-10 fish/lb. Five broods have been reared at BFH (1990-94) and one at WNFH (1995). Because the best rearing strategy for fall chinook salmon is unknown, we will compare SAS of yearling and subyearling releases from all hatcheries. Adult return data of fish reared at UFH will be complete by 2002.

Umatilla Fish Hatchery:

Juvenile Rearing and Survival Studies: No 1997 brood yearlings were reared at UFH in 1998-99. Past density and loading data from brood years 1994-97 is presented in Table 12.

Adult survival Studies: Adult recovery data from previous CWT releases is presented in Table 13. All data is incomplete.

Willard National Fish Hatchery:

Juvenile Rearing and Survival Studies: No 1997 brood yearlings were reared at WNFH in 1998-99. Past density and loading data from brood years 1994-97 is presented in Table 12.

Adult survival Studies: Adult recovery data from previous CWT releases is presented in Table 13. All data is incomplete.

Bonneville Fish Hatchery

Juvenile Rearing and Survival Studies*:* Juvenile rearing, release, and survival data for the 1997 brood is presented in Tables 14-16 and Appendix Tables A-1 and A-3. Fertilized eggs from Umatilla stock were incubated at UFH and 360,783 eyed embryos were transferred and ponded February 1998. Fish were transferred to the TH acclimation facility and examined for smolt condition on 17 February and 16 March 1999. The percentage of smolts, intermediate smolts, and parr was 50.0%, 50.0%, and 0.0% for the February group and 25.5%, 74.5%, and 0.0% for the March group. Percentage of descaled, partially

descaled, and no scale damage was 6.3%, 49.5%, and 44.2% for the February group and 12.1%, 68.7%, and 19.2% for the March group. Fin condition was slightly eroded on all groups.

Fish were CWT and BWT-tagged in October 1998 and retentions ranged from 94.7-95.4% and 90.7-91.1%. The 1997 brood was not marked with a right ventral clip. PIT-tagged fish from the first group released on 11 March were detected at JD Dam from 10 April to 8 May, and at BN Dam 24 April to 4 May. PIT-tagged fish from the second group released on 15 April were detected at JD Dam from 22 April to 24 May and at BN Dam 24 April to 19 May. The mean fork length (FL) of all fish at tagging (156.5 and 156.6 mm) was similar to the mean length at tagging (158.2 mm) of fish detected at JD and BN Dams.

***Adult survival studies**:* Recovery data from previous releases of CWT fish are presented in Table 13.

Adult Returns to the Umatilla River

A total of 717 fall chinook salmon returned to TMFD in 1998 (Appendix Table A-8). Vital statistics on adult returns and run timing are presented in Tables 17-18 and Figure 2. Fish were trapped from 8 September to 2 December. Subjacks (12) peaked on 30 September, while jack (12) and adult (40) returns peaked on 20 September and 12 November, respectively. Median dates were 8 October , 4 October, and 26 October for subjacks, jacks, and adults, respectively. Of 120 fish collected for CWT analysis, 93 were from Umatilla releases, 15 were strays, and 12 fish were of unknown origin or had lost tags. Strays were Lyons Ferry Hatchery (LFH) or Nez Perce releases of subyearlings (1) or yearlings (14) in the Snake River system. For UFH returns, subyearlings comprised 39% and yearlings 61% of 52 CWT's recovered from age 3+ salmon at TMFD.

Fishery

Catch and harvest data from the sport fishery for fall chinook salmon is presented in Tables 19-20. Anglers were mostly from Umatilla and Morrow counties (99.0%) with less than 1.0% from out of state. Almost all fall chinook and coho salmon fishing effort was below TMFD. Gear used was 99 % bait and lures and 1% flies.

Straying

Biologists collected 23 CWT'ed and 98 BWT'ed fish of Umatilla origin at Lower Granite Dam (LGD) in 1998 (Glen Mendel, Washington Department of Fish and Wildlife, personal communication). Expanded estimates based on marked to unmarked ratios were 116 adults and 19 jacks. The number of fish attributed to subyearling and yearling releases was 109 and 26, respectively. Estimated escapement of Umatilla fish past LGD was 12 adults and 3 jacks. Six CWT fish that voluntarily returned to LFH expanded to 25 fish (9 from subyearlings and 16 from yearlings). Non-CWT returns to LFH totaled 14 fish, including 9 right ventral clipped, 3 no marks, and 2 that were adipose clipped and BWT.

Two models that estimate future strays escaping past LGD from ODFW and National Marine Fisheries Service (NMFS) were expanded. Based on releases of 2.7 million subyearlings and 480,000 yearlings, the ODFW and NMFS models estimated that 17 and 20 fall chinook salmon of Umatilla origin would stray past LGD in future years (Table 21).

Discussion

Subyearlings, Rearing in Michigan and Oregon Raceways

A primary goal of this experiment was to compare SAS for fish reared in MI and OR raceways and among fish reared in different MI passes. Poor survival has limited CWT recovery (<35 per group) and invalidated some statistical tests. Moreover, poor survival limits evaluation of other experiments and achieve run goals. Subyearling survival has been well below the master plan goal of 0.30%. Improvement of SAS or increasing numbers of CWT needs to be answered before we continue experiments designed.3- to investigate specific hatchery rearing techniques.

Data from several hatcheries that reared subyearlings showed SAS varied greatly during the 1980-90's. Prior to the 1991 BY, SAS for subyearlings released in the Umatilla River followed the same trends as other mid-Columbia hatchery programs despite differences in release characteristics for each group (release location, size, date, etc). This suggests that survival is controlled by a primary mechanism such as ocean productivity. Of particular concern is the survival trend for fish released in the Umatilla River. Data from the 1993 and 1995 BY's indicate low SAS for fish released in the Umatilla River when most other groups increased. Explanations may include changes in rearing location, release date and size, release site, and in-river survival. Recent strategies to acclimate and release subyearlings higher in the Umatilla may be decreasing SAS. It is possible that rearing conditions at UFH are unsuitable for subyearlings. However, the 1984-90 broods were reared at Irrigon Fish Hatchery (IFH) and had relatively high SAS that were similar to other hatcheries. Both IFH and UFH have similar water quality and OR raceways. However, subyearlings at UFH were also reared in MI raceways. Again, because of low SAS there is no valid comparison between MI and OR raceways.

Release location in the Umatilla River may explain poor SAS of subyearlings from UFH. Fish released higher in the river may be exposed to mortality longer, reducing the number leaving the Umatilla River. Evidence for poorer survival for upriver releases is described in Knapp et al. (2000) and is suggested by SAS data. Knapp et al. (1998b) concluded that survival of juveniles out of the Umatilla River was as low as 18% for some broods. If this estimate is correct, less than 500,000 juveniles successfully migrated to the Columbia River in some years. Juveniles from the 1983-88 broods were released in the lower river (below RM 23) and corresponding SAS followed the trends of other hatcheries. Broods from 1988 to present were released in the middle or upper river (above RM 43) and have not followed mid-Columbia basin trends. Recent Yakima River releases were also in a tributary a considerable distance from the Columbia River. Release groups from the Yakima also show poor SAS that do not follow the trends of releases from other hatcheries. Most mid-Columbia hatcheries release fish directly into the Columbia River or in tributary locations a short distance from the Columbia River. Further, some groups are trapped and transported below BN Dam. These fish may avoid mortality factors experienced by fish released in the Umatilla River and migrating through the Columbia River pools in some years. Our first priority should be to accurately determine the abundance of outmigrants and ensure safe passage through the Umatilla River. Sources of in-river mortality are unknown, but could be related to predation, migration stress, or poor water quality.

Release size may affect SAS but does not explain the recent poor performance of Umatilla fish. Size of the 1983-90 BY's varied from 60-92 fish/lb yet SAS was similar to other hatcheries. Since the 1991 BY size-at-release of Umatilla fish has been similar or larger. At Priest Rapids Hatchery (PRH) fish are released considerably larger (approximately 40 fish/lb) than other hatchery groups and have greater SAS. Larger fish may better avoid predators and other migration hazards. In 2000, we will evaluate size-at-release by rearing and releasing groups of PIT-tagged fish that are greater than 60 fish/lb.

Subyearlings, density studies in Michigan raceways

Preliminary data indicate density has not affected rearing performance. At pre-release, length, weight, and condition factor varied more among BY's than among density groups. Moreover, descaling and smoltification are similar among density groups. Differences among BY's probably was caused by handling differences required during 4-5 weeks of tagging each year. Tagging times varied year to year because of tagging requirements. It may have also confounded food conversion calculations which varied from 1.61, 0.86, and 1.15 in 1996, 1997, and 1998 BY's.

Contrary to rearing data, information collected after fish were transferred to the acclimation ponds suggests greater differences between broods and rearing densities. Fish from the 1998 brood were longer (91 mm) and heavier (8.1 g or 56 fish/lb) than the 1996 or 1997 broods (6.8 g or 67 fish/lb). Larger size may have been a consequence of differences in rearing times between pre-release evaluations and transfer, length of acclimation, or warmer acclimation ponds.

Recoveries of PIT-tagged fish indicated a possible negative relationship between juvenile survival and rearing density. For both the 1997 and 1998 BY, the percent of fish detected at JD Dam declined as rearing density increased. Detection was 5.8, 5.2, and 5.1% for the 1997 BY (Hayes et al. 1999) and 9.7, 10.4, and 8.2% for the 1998 BY for fish reared at 200, 300, and 400K fish/raceway. Greater detection for larger fish at tagging was consistent among densities (Hayes et al. 1999). This information emphasizes the need to determine if juvenile and ultimately adult survival can be improved by increasing the release size. Because smolt size at release may be related to adult survival, we recommend more evaluation of this relationship by implementing hatchery practices that would increase release size. These practices might include earlier outside ponding, minimizing tagging effects, and delaying the release date**.**

Data collected from PIT-tagged fish for this study and the outmigration study (Knapp 2000) has provided an opportunity to gain preliminary information about the benefits of acclimation on juvenile performance. The percent of fish that were acclimated and detected at all sites was 10.4% and 36.7% in 1998 and 1999 compared to 10.6% and 27.1% for fish held at the hatchery, transported, and released directly below the outlet of the acclimation pond. Studies designed to answer questions about the benefits of acclimation should be planned.

Rearing density SAS data is not yet available. However, rearing efficiency will be greatly increased if the SAS of high density groups are comparable to low and medium density groups. A high density raceway contains 33% more fish (400,000) than the standard MI raceway (300,000 fish) and a SAS of 0.30% would produce 300 more adults. Total production could be increased without increasing the water supply. Final conclusions about the effects of rearing at different densities can only be determined as CWT data is collected.

Yearlings

Recent CWT data suggests poor SAS for yearlings released in the Umatilla River. For the 1990-94 BY's, SAS ranged from 0.02-0.22%, well below the 0.75% return goal. In comparison, SAS for LFH yearlings released in mid-April (1990-94 broods) released in the Snake River ranged from 0.08-1.00%.

Subjack returns represent lost adult production. It is suspected that overall production is small since shorter migration should increase survival. Studies determining saltwater entry and migration are planned for next report year. Size-at-release or growth rates may influence the early age at maturation. In 1998 we released approximately 450,000 CWT yearlings (1996 brood) reared at BFH that averaged 9.2 fish/lb.

This produced 230 subjack returns to TMFD. Methods required to determine production loss of smolts to this life-history strategy should be investigated.

Adult Returns to the Umatilla River

Based on numbers released and expected return rates of subyearlings (2.7 million and 0.30%) and yearlings (225,000 and 0.75%), nearly 10,000 fish should return annually to the Umatilla River (CTUIR and ODFW 1990). Adult counts at TMFD in 1998 were 869 fish and have averaged 301 fish since 1985. Historic data suggests total survival (ocean and freshwater) as great as 0.80% for subyearlings and 3.30% for yearlings in some years (Rowan 1998). However, because of exploitation, high total survival has never translated to large adult returns to the Umatilla River. Recent exploitation (>50%) coupled with poor ocean conditions suggest adult returns to the Umatilla River will continue to be lower than expected. Moreover, adult survival may be related to poor juvenile survival.

Adult return predictions to the Umatilla River using jack to adult ratios have been unreliable. Current predictions are based on pre-season forecasts of upriver brights to BN Dam and more run years of data are needed to improve reliability.

Data from CWT fish recovered at TMFD suggests differences in age at return for fish released as subyearlings and yearlings. As in past years, the majority (32/42) of age 2 fish returning to the Umatilla River originated from yearling releases. Fork lengths of age 2 yearlings ranged from 250-355 mm compared to 430-535 mm for age 2 subyearling releases in 1998.

Median return date for all ages of salmon in 1998 were similar to 1996 and 1997 observations. Respective dates for 1996-98 were: subjacks – 8, 14, and 8 October; jacks – 11, 15, and 4 October, and adults – 17, 19, and 26 October.

Fishery

Fishing effort for fall chinook and coho salmon in 1998 (3,299 h) was within the range (1,666 – 3,789 h) previously reported (Hayes et al. 1999). Catch rates (0.05 and 0.03 fish/h) and harvest for jack and adult chinook (87) and coho (89) salmon were also within the range previously reported, but about half as great as in 1997. Harvest estimates below TMFD plus run counts at TMFD were 943 and 974 for chinook and coho salmon. The harvest represented 11% (87/943) and 3% (89/3,366) of the 1998 fall chinook and coho salmon runs (subjack, jacks and adults). We previously speculated that the increased harvest in 1997 indicated that anglers were learning how to target this fishery. However, the low catch of coho in a year when they were relatively abundant suggests these fish are not caught in proportion to their abundance.

Straying

Adults from releases of juvenile fall chinook salmon in the Umatilla River continue to stray into the Snake River. Counts of salmon (all stocks) at LGD in 1998 were 1,909 adult and 2,002 jacks (G. Mendel Washington Department of Fish and Wildlife, personal communication). Umatilla River releases contributed 6% of the adult hatchery run to LGD compared to 14% in 1997 and escapement was only 12 of 962 fish (1.2%). However, strays from all groups totaled 18% suggesting that wire-tagging should be continued to effectively manage stray escapement.

Adult returns to TMFD were 717 fish in 1998. Of these, 601 fish (83.8%) were from Umatilla releases. If the 135 strays collected in the Snake River had returned to the Umatilla River, the run would

have increased by 22%. Similar calculations for 1997 showed the run would have increased by 21% if strays had homed to the Umatilla River. We recommend continual investigations to reduce straying.

Table 1. Exploitation and survival of subyearling fall chinook salmon that were coded-wire-tagged (CWT) and released in the Umatilla River, 1991-95 broods. Recoveries include age 3 and older fish. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 2000.

Brood year, CWT code	Raceway	N[a]	Total exploi-tation (%)	Umatilla return (% of release)	Total survival (% of release)	Number of jacks and adults recovered
1991						
071433	M2A	0	0.0	0.00	0.00	0
071434	M3A	0	0.0	0.00	0.00	0
071435	M2B	0	0.0	0.00	0.00	0
071436	M3B	1	0.0	<0.01	<0.01	10
071437	M2C	1	0.0	<0.01	<0.01	7
071438	M3C	0	0.0	0.00	0.00	0
Subtotal/Average		2	0.0	<0.01	<.0.01	17
071430	O2A	3	66.7	<0.01	0.01	26
071429	O3A	1	0.0	<0.01	<0.01	9
071432	O2B	0	0.0	0.00	0.00	0
071431	O3B	0	0.0	0.00	0.00	0
Subtotal/Average		4	16.7	<0.01	<0.01	35
Total/Average		6	8.3	<0.01	<0.01	52
1992						
076330	M2A	14	57.1	0.01	0.05	142
070127	M2B	19	63.2	0.03	0.07	189
076331	M3A	17	58.8	0.02	0.06	162
076333	M3B	21	52.4	0.02	0.07	193
076334	M2C	8	37.5	0.02	0.03	75
076332	M3C	16	75.0	0.01	0.05	151
Subtotal/Average		95	57.3	0.02	0.05	913
070126	O2A	21	57.1	0.02	0.07	190
070125	O3A	13	61.5	0.01	0.04	121
076329	O2B	19	63.2	0.01	0.06	126
076335	O3B	15	33.3	0.03	0.05	102
Subtotal/Average		68	53.8	0.02	0.06	539
Total/Average		163	55.6	0.02	0.06	1,452

[a] *Expanded CWT recoveries.*

Table 1 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploitation (%)	Umatilla return (% of release)	Total survival (% of release)	Number of jacks and adults recovered
1993						
070663	M2A	16	75.0	0.01	0.05	166
070719	M3A	24	75.0	0.00	0.08	248
070720	M2B	32	78.1	0.01	0.10	330
070723	M3B	8	62.5	0.01	0.03	86
070722	M2C	26	42.3	0.04	0.08	255
070721	M3C	14	28.6	0.02	0.05	151
Subtotal/Average		120	60.3	0.02	0.07	1,235
070662	O2A	26	80.8	0.01	0.08	233
070716	O2B	27	74.1	0.02	0.09	169
070718	O3A	2	0.0	0.01	0.01	18
070717	O3B	31	71.0	0.02	0.10	182
Subtotal/Average		86	56.5	0.02	0.07	602
Total/Average		206	58.4	0.02	0.07	1,838
1994						
071019	M2A	0	0.0	0.00	0.00	0
071017	M3A	0	0.0	0.00	0.00	0
071022	M2B	0	0.0	0.00	0.00	0
071020	M3B	0	0.0	0.00	0.00	0
071025	M2C	0	0.0	0.00	0.00	0
071023	M3C	0	0.0	0.00	0.00	0
Subtotal/Average		0	0.0	0.00	0.00	0
071026	O2A	0	0.0	0.00	0.00	0
071018	O3A	1	0.0	<0.01	<0.01	8
071024	O2B	1	100.0	0.00	0.00	5
071021	O3B	0	0.0	0.00	0.00	0
Subtotal/Average		2	25.0	<0.01	<0.01	13
Total/Average		2	20.8	<0.01	<0.01	13

Table 1 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploitation (%)	Umatilla return (% of release)	Total survival (% of release)	Number of jacks and adults recovered
1995						
071320	M2A	2	0.0	0.01	0.01	20
071323	M2B	4	0.0	0.01	0.01	40
071321	M3A	1	0.0	0.00	0.00	10
071325	M3B	0	0.0	0.00	0.00	0
071157	M2C	2	0.0	0.01	0.01	26
071327	M3C	1	0.0	0.01	0.00	16
Subtotal/Average		10	0.0	0.01	0.01	113
071322	O2A	6	16.7	0.02	0.02	54
071324	O3A	2	0.0	0.01	0.01	18
071326	O2B	4	0.0	0.01	0.01	24
071328	O3B	0	0.0	0.01	0.00	0
Subtotal/Average		12	4.2	0.01	0.01	90
Total/Average		22	2.1	0.01	0.01	186

Table 2. Recovery location of estimated number of adult (age 3+) fall chinook salmon produced by releases of subyearlings in the Umatilla River, brood years 1991-95.

Brood year	Number released	Ocean catch	Columbia River		Umatilla escapement	Umatilla sport	Upriver strays	Total recoveries
			Net	Sport				
1991	2,678,343	0	17	0	35	0	0	52
1992	2,629,917	404	458	27	473	0	123	1,485
1993	2,843,212	698	372	176	451	0	134	1,830
1994	2,466,298	0	17	17	8	0	0	41
1995	3,211,995	451	65	0	194	0	0	728

Table 3. Egg-take and survival of subyearling fall chinook salmon reared at Umatilla Hatchery, 1996-98 broods.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt survival[a] (%)
Priest Rapids	1996	3,358,649	73.2	
Umatilla River		778,028	63.6	
Total		4,136,677	71.3	62.4
Priest Rapids	1997	4,427,536	71.3	67.5
Priest Rapids	1998	1,561,924	70.2	
Little White Salmon		1,838,195	49.6	
Total		3,400,119	59.0	54.4

[a] *Survival estimate is based on numbers of green eggs and smolts released..*

Table 4. Rearing conditions immediately before transfer for subyearling fall chinook salmon at three densities in Michigan series at Umatilla Hatchery in 1998-99, 1997 brood.

Brood year	Series	Mean number per raceway	Maximum density ($lb/ft^{3)}$	Maximum loading (lb/gal/min)	Number reared per gpm[a]
1996	M4	199,540	1.0-1.1	2.3-2.7	617
1996	M1	299,817	1.6-1.7	3.7-3.9	940
1996	M2	366,920	1.7-2.1	4.0-4.9	1,159
1997	M2	211,526	1.2-1.4	2.9-3.2	668
1997	M3	308,855	1.6-1.8	3.9-4.3	975
1997	M4	407,367	2.1-2.3	5.0-5.3	1,286
1998	M2	187,235	1.1-1.2	2.6-2.7	427
1998	M3	324,797	1.5-1.9	3.7-4.6	651
1998	M4	411,114	1.9-2.6	4.4-6.1	865

[a] *Numbers are combined production for three Michigan passes. The 1998 brood was reared in first and second pass raceways only.*

Table 5. Mean length, weight, and condition factor for subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery and at Imeques acclimation raceways in 1999, 1998 brood.

Sample date, Density	Pass or Race-way	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
31 March:							
200,000	A	115	63.4(0.4)	48	3.0(0.1)	48	1.21(0.02)
	B	94	62.7(0.4)	65	3.1(0.1)	65	1.25(0.02)
300,000	A	94	63.4(0.4)	44	3.1(0.1)	44	1.16(0.02)
	B	93	60.0(0.5)	93	2.7(0.1)	93	1.21(0.01)
400,000	A	114	62.2(0.4)	76	2.9(0.1)	76	1.17(0.02)
	B	110	61.6(0.4)	58	2.7(0.1)	58	1.15(0.03)
7-11 May							
200,000	A	715	79.6(0.2)	125	5.5(0.1)	125	1.07(0.01)
	B	587	79.3(0.2)	106	5.8(0.1)	106	1.20(0.01)
300,000	A	451	82.5(0.4)	111	6.3(0.1)	111	1.14(0.01)
	B	586	76.9(0.3)	92	5.2(0.1)	92	1.13(0.01)
400,000	A	567	75.8(0.2)	99	4.6(0.1)	99	1.07(0.01)
	B	708	77.5(0.3)	199	6.4(0.1)	199	1.19(0.01)
3 June	1	297	92.1 (0.4)	214	8.3(0.1)	214	1.03 (0.01)
(Imeques)	2	225	90.8 (0.5)	225	8.1(0.1)	225	1.07 (0.01)
	3	258	90.0 (0.5)	258	7.8(0.1)	258	1.05 (0.01)
Total/mean		780	91.0 (0.3)	697	8.1(0.1)	697	1.05 (0.00)

Table 6. Summary of pre-release data for subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery, 1996-98 broods. Data were collected 10-14 days prior to transfer to acclimation ponds[a].

Brood year	Density(*1000)	Pass	Legnth(mm)	Weight(g)	Condition factor
1996	200	A	75.4	4.9	1.11
	300	A	79.5	5.6	1.06
	400	A	75.5	4.9	1.10
1997	200	A	77.9	4.9	1.03
	300	A	77.3	4.8	1.08
	400	A	78.0	4.5	1.00
1998	200	A	79.6	5.5	1.07
	300	A	82.5	6.3	1.14
	400	A	75.8	4.6	1.07
1996	200	B	77.3	5.3	1.12
	300	B	78.3	5.8	1.16
	400	B	77.9	5.4	1.11
1997	200	B	77.3	4.6	0.97
	300	B	79.3	4.4	0.89
	400	B	76.6	3.7	0.82
1998	200	B	79.3	5.8	1.20
	300	B	76.9	5.2	1.13
	400	B	77.5	6.4	1.19
1996	200	C	79.7	5.9	1.14
	300	C	78.0	5.3	1.08
	400	C	78.1	5.7	1.17
1997	200	C	78.5	5.4	1.07
	300	C	77.6	4.7	0.97
	400	C	75.3	4.4	1.00

[a] *No fish from the 1998 brood were reared in third pass (C) raceways.*

Table 7. Summary of release data for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River, 1996-98 broods. Data were collected immediately prior to release from the acclimation raceways.

Brood year	Acclimation pond	Length	Weight	Condition factor
1996	Imeques-1	84.3	6.7	1.13
	Imeques-2	85.4	6.8	1.06
	Imeques-3	85.3	6.4	1.00
	Imeques-4	85.1	6.7	1.07
	Thornhollow-1	85.2	7.0	1.10
	Thornhollow-2	83.5	6.2	1.05
Mean		84.8	6.7	1.07
1997	Imeques-1	84.5	6.5	1.07
	Imeques-2	86.0	6.8	1.07
	Imeques-3	85.5	6.8	1.06
	Imeques-4	85.0	6.8	1.08
	Thornhollow-1	85.3	6.9	1.12
	Thornhollow-2	85.2	7.1	1.15
Mean		85.4	6.8	1.09
1998	Imeques-1	92.1	8.3	1.03
	Imeques-2	90.8	8.1	1.07
	Imeques-3	90.0	7.8	1.05
Mean		91.0	8.1	1.05

Table 8. Mean percent of descaled, partially descaled, and undamaged subyearling fall chinook salmon reared at three densities in Michigan raceways at Umatilla Hatchery in 1999, 1998 brood.

Raceway	Density	Descaled[a]	Partially descaled[b]	Undamaged[c]
M2A	200,000	0.0	18.5	81.5
M2B		0.0	27.1	72.9
M3A	300,000	0.8	26.6	72.6
M3B		0.0	17.9	82.1
M4A	400,000	0.0	3.0	97.0
M4B		3.8	78.8	17.3

[a] *More than 0.20 descaling on either side of the fish.*
[b] *Descaling = 0.03 to 0.20 on either side of the fish.*
[c] *Less than 0.03 descaling on either side of the fish.*

Table 9. Tag and mark information for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River in 1999, 1998 brood (CWT = coded-wire tag).

Raceway and PTAGIS PIT tag file	Release date	CWT code	Number recognizably CWT and clipped[a]	Number PIT-tagged fish released	PIT tags extruded after 48 h (%)	PIT tag mortalities after 48 h (%)	Total number released
M2A WAC99125.M2A	6/3/99	092701	64,881	590	0.0	0.0	169,943
M2B WAC99124.M2B	6/3/99	092663	66,220	585	0.0	0.0	203,951
M3A WAC99125.M3A	6/3/99	092703	65,821	583	0.0	0.0	342,651
M3B WAC99124.M3B	6/3/99	092702	63,127	582	0.0	0.0	305,731
M4A WAC99123.M4A	6/3/99	092705	63,147	564	0.0	0.0	411,966
M4B WAC99124.M4B	6/3/99	092704	63,757	585	0.0	0.0	408,424
Total			386,953	3,489	0.0	0.0	1,842,666

[a] *All fish with CWT were adipose fin-clipped.*

Table 10. Percent and number detected, median travel time and passage date at John Day and Bonneville dams for subyearling fall chinook salmon reared at three densities, PIT-tagged, and released in the Umatilla River, spring 1999.

		John Day			Bonneville		
Raceway	Density	Percent detected (number)	Median travel time (d)	Median passage date	Percent detected (number)[a]	Median travel time (d)	Median passage date
			Summarized by raceway				
M2A	200,000	9.3(55)	19	6/22/99	5.1(30)	21	6/24
M2B	200,000	10.1(59)	17	6/20/99	5.5(32)	19	6/22
M3A	300,000	8.9(52)	18	6/21/99	4.3(25)	21	6/24
M3B	300,000	11.9(69)	18	6/21/99	4.3(25)	22	6/25
M4A	400,000	8.0(45)	19	6/22/99	3.7(21)	18	6/21
M4B	400,000	8.4(49)	18	6/21/99	4.3(25)	20	6/23
			Summarized by rearing density group				
M2	200,000	9.7(114)	18	6/21/99	5.3(62)	20	6/23
M3	300,000	10.4(121)	18	6/21/99	4.3(50)	21	6/24
M4	400,000	8.2 (94)	18	6/21/99	4.0(46)	18	6/21

[a] *Percent and number detected at Bonneville Dam includes the following numbers of PIT-tagged fish previously detected at John Day Dam: 6-M2A, 12-M2B, 5-M3A, 11-M3B, 4-M4A, 6-M4B.*

Table 11. Percent and number detected at John Day and Bonneville dams (combined) by length at tagging for subyearling fall chinook salmon PIT-tagged, and released in the Umatilla River, spring 1999.

Fork length group (mm)	Density			Total
	200K	300K	400K	
60-64	13.8 (4)		12.5 (2)	12.8 (6)
65-69	7.5 (8)	7.4 (4)	14.3 (7)	9.1 (19)
71-74	11.5 (36)	12.1 (20)	8.9 (14)	11.0 (70)
75-79	9.4 (36)	10.9 (40)	16.5 (40)	11.7 (116)
80-84	14.4 (33)	15.4 (53)	15.3 (44)	15.1 (130)
85-89	15.6 (12)	17.5 (37)	12.6 (15)	15.7 (64)
90-94	14.3 (1)	10.7 (3)	10.0 (3)	10.8 (7)
95-99		33.3 (1)	9.1 (1)	14.3 (2)
Total	11.4 (130)	13.5 (158)	13.8 (126)	12.8 (414)

Table 12. Rearing conditions for yearling fall chinook salmon in Michigan and Oregon raceways at Umatilla, Bonneville, and Willard hatcheries, 1994-97 broods.

Brood year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)	Number reared per gpm
		Umatilla Hatchery		
1994	Michigan	3.9-4.0	9.5	151
1995	Michigan	2.6-3.0	6.2-7.1	165
1995	Oregon	1.0-1.1	4.9-5.3	82
		Bonneville Hatchery		
1994	Oregon	0.8-1.0	6.0-7.0	58
1996	Oregon	0.4-0.8	2.9-5.8	53
1997	Oregon	0.8-1.0	5.7-6.6	65
		Willard Hatchery		
1995		1.4-2.6	4.1-7.5	69
1996		1.1-2.2	3.3-6.4	40

Table 13. Exploitation and survival of yearling fall chinook salmon reared at Umatilla, Bonneville, and Willard hatcheries, coded-wire-tagged (CWT), and released in the Umatilla River, 1990-96 broods. Recoveries include age 3 and older fish. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 2000.

Brood year, CWT code	Raceway	N[a b]	Total exploi-tation (%)	Umatilla return (% of release)	Total survival (% of release)	Number of jacks and adults recovered
			Umatilla Hatchery			
1994						
071039	M3A	0	0.00	0.00	0.00	0
071040	M3B	1	0.00	<0.01	<0.01	2
071041	M3C	0	0.00	0.00	0.00	0
Total/Mean		1	0.00	<0.01	<0.01	2
1995						
091729	O3A	0	0.00	0.00	0.00	0
091748	O3B	0	0.00	0.00	0.00	0
Total/Mean		0	0.00	0.00	0.00	0
071358	M1A	0	0.00	0.00	0.00	0
091807	M1B	0	0.00	0.00	0.00	0
071359	M1C	0	0.00	0.00	0.00	0
Total/Mean		0	0.00	0.00	0.00	0
Total/Mean		0	0.00	0.00	0.00	0
			Bonneville Hatchery			
1990						
075618	A8	0	0.00	0.00	0.00	0
075619	A9	0	0.00	0.00	0.00	0
Total/Mean		0	0.00	0.00	0.00	0
1991						
071460	A5	3	33.3	<0.01	0.01	9
071461	A6	9	44.4	0.02	0.04	26
Total/Mean		12	38.9	0.01	0.03	34

[a] *Expanded CWT recoveries.*

[b] *Observed recoveries of age two subjacks (<381 mm FL) for each tag code were:71039-2, 071040-7, 071041-12; 091729-13, 091748-24, 091358-20, 091807-22, 091359-29 : 071460 – 3, 071461 - 3.*

Table 13 (continued)

Brood year, CWT code	Raceway	N[a b]	Total exploi-tation (%)	Umatilla return (% of release)	Total survival (% of release)	Number of jacks and adults recovered
1992						
070252	A5	13	00.0	0.01	0.06	28
070255	A6	41	43.9	0.07	0.17	404
Total/Mean		54	22.0	0.04	0.11	432
1993						
070658	A2	10	30.0	0.03	0.04	45
070659	A6	0	0.00	0.00	0.00	0
Total/Mean		10	15.0	0.01	0.02	45
1994						
071037	A4	2	0.00	<0.01	<0.01	15
071038	A3	0	0.00	0.00	0.00	0
Total/Mean		2	0.00	<0.01	<0.01	15
1996						
92037	A11	0	0.00	<0.00	<0.01	00
			Willard Hatchery			
1995						
070953		0	0.00	0.00	0.00	0
070954		0	0.00	0.00	0.00	0
Total/Mean		0	0.00	0.00	0.00	0

[a] *Expanded CWT recoveries*

[b] *Additional recoveries of age two subjacks (<381 mm FL) for each tag code were: 070252 - 15, 070255 - 34, 070658 - 47, 070659 - 27, 071037 - 57, 071038 – 23, 070954-1.*

Table 14. Mean length, weight, and condition factor for yearling fall chinook salmon (BY 1997) reared at Bonneville Hatchery and Thornhollow Acclimation facility for release in the Umatilla River in 1999.

Sample, date	Race-way	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
Bonneville Hatchery							
Pre-release:							
17 Feb	A5	255	156.5(1.0)	98	44.2(1.0)	98	1.12(0.01)
16 Mar	A11	257	156.1(1.0)	98	41.0(0.9)	101	1.10(0.01)
Thornhollow Acclimation Facility							
Release:							
11 Mar	TH1	335	160.2(0.7)	123	47.3(1.0)	123	1.11(0.01)
	TH2	338	162.1(0.7)	103	49.4(1.1)	103	1.12(0.01)
15 Apr	TH1	320	165.3(0.8)	107	48.4(1.1)	107	1.10(0.00)
	TH2	311	165.4(0.7)	105	52.0(1.3)	105	1.10(0.00)

Table 15. Tag and mark information for yearling fall chinook salmon reared at Bonneville Hatchery and released in the Umatilla River in 1999, 1997 brood (CWT = coded-wire tag, AD = adipose fin).

Raceway and PTAGIS PIT-tag file	Release date	CWT code	Number recognizably CWT and clipped[a]	Number PIT-tagged fish released	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
A5 WAC99049.TH1	3/11/99	092651	24,693	248	0.4	1.6	233,861
A11 WAC99075.TH2	4/15/99	092037	24,402	236	6.3	1.6	215,707

[a] *All fish with CWT were adipose fin clipped.*

Table 16. Number and percent detected, and median travel time and passage date at John Day and Bonneville dams for yearling fall chinook salmon reared at Bonneville hatchery, PIT-tagged and released in the Umatilla River, spring 1999.

Release Date, Raceway(s)	CWT code	John Day Percent detected (number)	John Day Median travel time (d)	John Day Median detection date	Bonneville Percent detected (number)	Bonneville Median travel time (d)	Bonneville Median detection date
3/11/99 A1-A5	092651	10.9(27)	43	4/23/99	2.4(6)	49	4/29/99
4/15/99 A6-A11	092037	15.3(36)	23	5/8/99	5.9(14)	21	5/6/99

Table 17. Number of fall chinook salmon that returned to the eastbank fish ladder, Three Mile Dam, Umatilla River, 1995-98.

Age[a]	Male Number	Male %	Female Number	Female %	Total Number	Total %
			1995			
Subjack	338	100.0	0	0.0	338	27.5
Jack	286	99.3	2	0.7	288	23.4
Adult	360	59.7	243	40.3	603	49.1
Total	984	80.1	245	19.9	1,229	100.0
			1996			
Subjack	606	100.0	0	0.0	606	45.5
Jack	80	100.0	0	0.7	80	6.0
Adult	357	55.3	289	44.7	646	48.5
Total	1,043	78.3	289	21.7	1,332	100.0
			1997			
Subjack	189	100.0	0	0.0	189	25.2
Jack	207	100.0	0	0.0	207	27.6
Adult	127	35.9	227	64.1	354	47.2
Total	523	69.7	227	30.3	750	100.0
			1998			
Subjack	223	97.0	7	3.0	230	34.3
Jack	127	82.5	27	17.5	154	23.0
Adult	220	76.9	66	23.1	286	42.7
Total	585	85.1	128	14.9	670	100.0

[a] *Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm.*

Table 18. Vital statistics of fall chinook salmon that returned to the eastbank fish ladder, Three Mile Dam, Umatilla River in 1998 by release strategy and hatchery. Data was determined from coded-wire tag recovery (sex was determined visually, all age 2 fish were assumed to be male).

Hatchery Brood year	Age	Number	Sex	Fork length (mm) mean	 min	 max
			Subyearling Release			
Umatilla						
1993	5	2	male	741	741	741
1995	3	17	male	673	601	850
	3	1	female	701		
1996	2	9	male	488	430	535
Lyons Ferry Hatchery						
1996	2	1	male	490		
			Yearling Release			
Umatilla Hatchery						
1995	3	22	male	588	470	665
	3	1	female	535		
Bonneville Hatchery						
1993	5	2	male	872	795	948
1994	4	5	male	767	710	805
1996	2	4	male	326	310	355
Willard Hatchery						
1995	3	2	male	528	525	530
1996	2	24	male	313	250	350
	2	4	female	325	285	355
Lyons Ferry Hatchery						
1995	3	12	male	555	460	675

Table 19. Estimated catch statistics for fall chinook and coho salmon in the lower Umatilla River from the mouth to Three Mile Falls Dam during 1998. Number caught and number harvested includes ± 95% confidence interval.

				Fall Chinook Salmon					
				Adult Salmon[a]			Jack Salmon		
Month, Day type	Number Days	sampled Anglers	Hours fished	Number caught	Number harvested[a]	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	9	14	97	10±11	0± 0	0.10	13±22	13±22	0.14
Weekend	7	25	113	7±11	0± 0	0.06	3± 6	0± 0	0.03
Total	16	39	210	17±16	0± 0	0.08	16±23	13±22	0.08
October									
Weekday	10	125	984	5± 8	0± 0	0.01	65±56	40±38	0.07
Weekend	9	194	869	6±22	3±11	0.01	29±43	20±31	0.03
Total	19	319	1,853	11±23	3±11	0.01	94±71	60±48	0.05
November									
Weekday	6	44	535	17±34	0± 0	0.03	8±14	8±14	0.01
Weekend	9	147	701	1± 1	0± 0	0.00	3± 4	3± 4	0.00
Total	15	191	1,236	18±34	0± 0	0.01	11±15	11±15	0.01
Grand Total	50	549	3,299	46±44	3±11	0.01	131±75	84±55	0.03

				Coho Salmon					
				Adult Salmon			Jack Salmon		
Month, Day type	Number Days	sampled Anglers	Hours fished	Number caught	Number harvested	Catch rate fish/h	Number caught	Number harvested	Catch rate (fish/h)
September									
Weekday	9	14	97	0± 0	0± 0	0.00	0± 0	0± 0	0.00
Weekend	7	25	113	0± 0	0± 0	0.00	0± 0	0± 0	0.00
Total	16	39	210	0± 0	0± 0	0.00	0± 0	0± 0	0.00
October									
Weekday	10	125	984	43±32	43±32	0.04	25±22	20± 20	0.03
Weekend	9	194	869	11±10	11±10	0.01	12± 8	13± 8	0.01
Total	19	319	1,853	54±33	54±33	0.03	37±24	33±21	0.02
November									
Weekday	6	44	535	0± 0	0± 0	0.00	0± 0	0± 0	0.00
Weekend	9	147	701	2± 2	2± 2	0.00	0± 0	0± 0	0.00
Total	15	191	1,236	2± 2	2± 2	0.00	0± 0	0± 0	0.00
Grand Total	50	549	3,299	56±33	56±33	0.01	37±23	33±21	0.01

[a] *Harvest of adult fall chinook salmon was legal below Highway 730.*

Table 20. Summary of fall chinook and coho salmon catch statistics, Umatilla mouth to Three Mile Falls Dam, 1992-98.

			Chinook salmon			Coho salmon		
Year	Sampled anglers	Hours fished	Number caught	Number/ harvested	Catch rate (fish/h)	Number caught	Number harvested	Catch rate (fish/h)
1992	562	2,210	148	41	0.067	132	105	0.060
1993	639	1,666	15	9	0.009	53	53	0.032
1994	596	2,898	250	73	0.086	75	33	0.026
1995	517	2,201	120	46	0.055	55	48	0.023
1996	665	3,789	289	177	0.076	96	96	0.023
1997	434	2,742	288	192	0.105	195	171	0.071
1998	549	3,299	167	87	0.054	93	89	0.028

Table 21. Number of fall chinook salmon planned for 2000 release in the Umatilla River and predicted escapement of stray returning adults above Lower Granite Dam using models developed by the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service.

Oregon Department of Fish and Wildlife model

Group	Juveniles released into the Umatilla River	Strays above Lower Granite Dam		
		Low	Mean	High
Subyearlings	2,682,000	2	14	37
Yearlings	480,000	0	3	13
Total	3,162,000	2	17	40

National Marine Fisheries Service Model

	Stray fish to Lower Granite Dam		Strays above Lower Granite Dam			Juveniles released into the Umatilla River	
Return year	Umatilla	Other	Umatilla	Other	Total	Number	Years
1992	41	2	4	2	6	3,450,000	1988-91
1993	195	10	20	10	30	3,430,000	1989-92
1994	268	18	27	18	45	3,279,000	1990-93
1995	285	114	29	114	143	3,201,000	1991-94
1996	50	213	5	200	205	3,057,821	1992-95
1997	124	212	40	172	212	3,118,935	1993-96
1998	135	220	12	165	177	3,252,087	1994-97
Average	157	113	20	97	117	3,255,549	1988-97

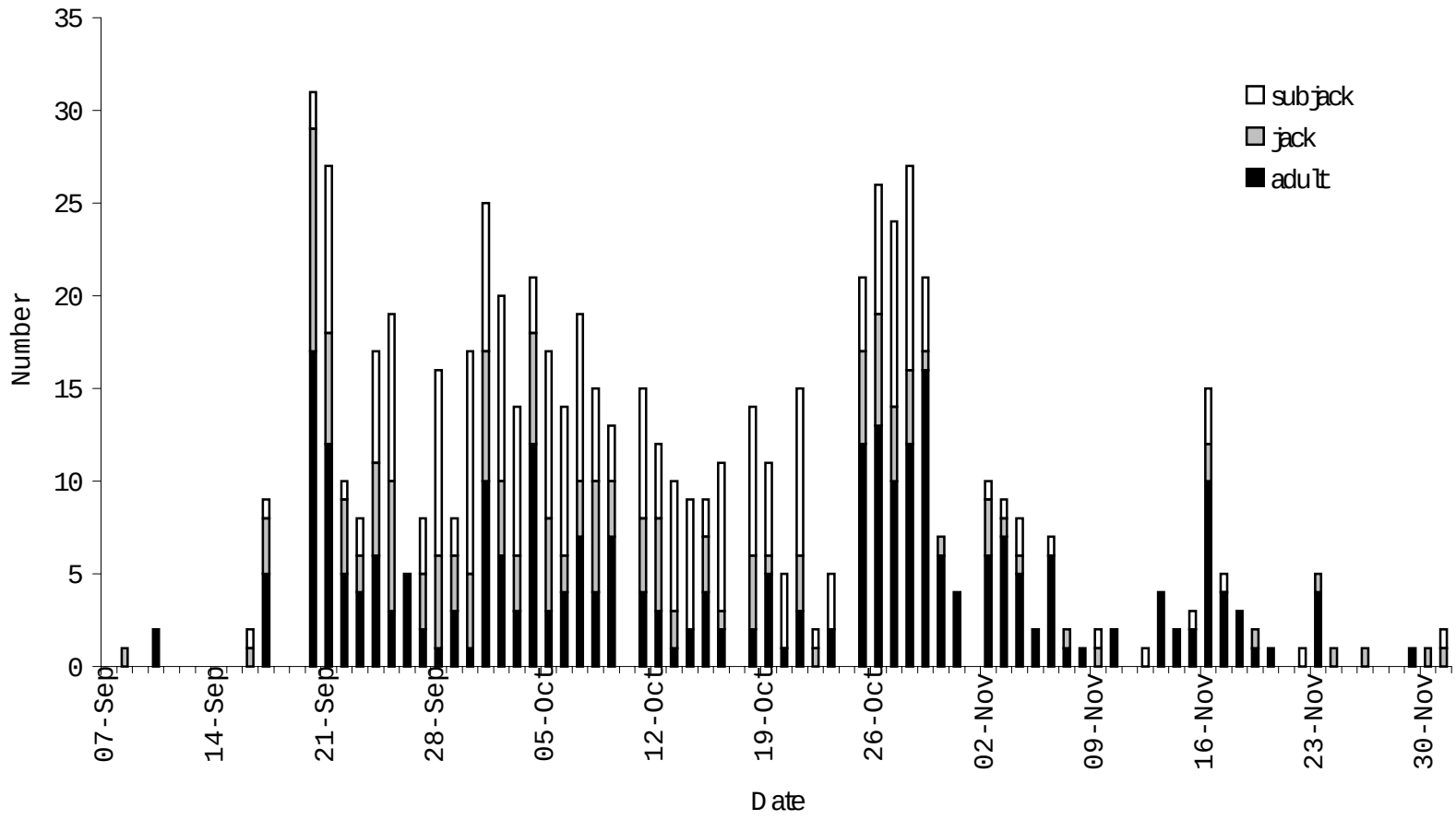

Figure 2. Numbers of subjack, jack, and adult fall chinook salmon counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1998.

SPRING CHINOOK SALMON

Overview

To restore spring chinook salmon to the Umatilla River, spring-released yearlings and subyearlings, and fall-released subyearlings release strategies have been evaluated at UFH. Six yearling broods (1991-97) were reared at UFH. The yearling release strategy is considered experimental because embryos are chilled to retard size to 12 fish/lb at spring release. Additional yearlings for release in the Umatilla River are also reared at BFH, Little White Salmon National Fish Hatchery (LWSFH), and Carson National Fish Hatchery (CNFH). These groups are used to compare the success of fish produced at UFH. Subyearlings were reared (1991-93 broods) because of the rapid growth potential in warm water. The subyearling strategy has been eliminated because size-at-release goals were not attained and near zero SAS. Subyearlings were also released in the fall (1991-93 broods) because additional rearing space was available and fall releases had shown some success in the Willamette River. Smolt-to-adult survival of the fall release strategy was poor and releases were discontinued; however, this strategy may be resumed depending on space and budget.

Methods

Subyearlings

Juvenile Rearing and Survival Studies: No subyearlings were reared in 1999. Methods were described in previous annual reports.

Adult Survival Studies: Methods to determine SAS were the same as described for fall chinook salmon.

Fall Release

Juvenile Rearing and Survival Studies: No fish for fall release were reared in 1997-99. Methods were described in previous annual reports.

Adult Survival Studies: Methods to determine SAS were the same as described for fall chinook salmon.

Yearlings

Juvenile Rearing and Survival Studies: Methods in rearing and survival studies were the same as described for subyearling fall chinook salmon. However, one OR raceway series was transferred in the fall to evaluate cold-water winter rearing. Methods to PIT-tag smolts were the same as described for yearling fall chinook salmon except that approximately 250 fish from UFH were collected tagged at IFH and held 48 h in circular tanks. Yearlings from LWSFH and CFH were PIT-tagged at IC.

Adult Survival Studies: Methods to determine SAS were the same as described for fall chinook salmon.

Adult Returns to the Umatilla River

Methods to collect data on spring chinook salmon returns and survival estimates were the same as described for fall chinook salmon.

Fishery

Except for the following modifications, spring salmon sport fisheries were surveyed as described in the 1993-98 annual reports. The 1999 survey of the spring chinook salmon sport fishery went from 29 May until 20 June in two river sections. The lower section began at TMFD and ended at Yoakum bridge (RM 37). The upper section went from Yoakum bridge to CTUIR boundary (RM 55). Harvest regulations were 2 fish/day and 4 fish/year. Each survey went from sunrise to 1400 because previous data indicated that only 4% of the harvest was after 1400. Creel data was stratified by weekend/holiday or weekday and expanded for total effort and days not sampled.

Results

Subyearlings

Overview: One brood (1991) of subyearling spring chinook salmon was reared in OR raceways and three broods (1991-93) were reared in MI raceways at UFH (Appendix Table A-4). Study objectives were to evaluate the subyearling rearing strategy by comparing rearing conditions and cost, juvenile migration, and SAS between subyearlings produced in MI and OR systems and among passes within MI system. Adult returns will be completed in 1999.

Juvenile Rearing and Survival Studies: No subyearlings were reared at UFH in 1999. Juvenile data at pre-release and release were presented in earlier annual reports (Keefe et al. 1993 and 1994).

Adult Survival Studies: Because of low SAS there is no valid comparison between MI and OR or among MI raceways.

Fall Release

Overview: The 1991 BY was reared at BFH in OR raceways and 1991-93 BY's were reared at UFH in MI or OR raceways (Appendix Table 5). The objectives were to compare rearing conditions and cost, juvenile migration, SAS for fish produced in MI and OR systems and among MI passes. Fish reared in OR raceways at UFH were compared to fish in OR raceways at BFH. Completed adult returns will be available in 1999.

Juvenile Rearing and Survival Studies: No fish from the 1997 brood were reared for fall release in 1998. Smolt condition and survival from previous releases were presented in Keefe et al. (1993, 1994, and 1995) and Hayes et al. (1996).

Adult Survival Studies: Recovery data of previously released CWT groups are presented in Table 22. Total survival rates for all groups have been poor (<0.10%); however, survival of broods reared in MI and OR raceways was similar. Survival of the 1991 brood reared at UFH was poorer than groups reared at BFH.

Yearlings

Overview: The 1991-92 BY's were reared at BFH in OR raceways and UFH in OR raceways. The 1993-94 BY were reared at UFH in MI and OR raceways. The 1995 BY was reared at UFH in OR raceways. The 1996-97 BY's were reared at UFH in MI and OR raceways and at CNFH and LWSFH in standard raceways. Embryos at UFH are chilled to retard growth and meet size-at-release goals. Release goals at UFH were reduced to 15 fish/lb for the 1997 brood. Eyeing and hatch were synchronized at UFH by incubating different egg takes at different temperatures. The objectives were to compare rearing conditions and cost, juvenile migration, and SAS for yearlings produced in MI and OR raceways at UFH and standard raceways at BFH, CFH, and LWSFH. Completed adults returns will be available in 2003.

Umatilla Hatchery:

Juvenile Rearing and Survival Studies*:* Data on fish length, weight, and condition are presented in Tables 23-29. Yearlings were ponded in one OR raceway in May 1998. At the end of July they were split between a MI and OR raceway at 105.0 and 87.8 fish/lb. In August they were split into four OR and three MI raceways. Water quality in MI raceways was within favorable limits between the inlet and outlets. Artificially maintained oxygen was significantly different among raceways (Tables 24 and 25). One OR series (O4A and B) was transferred to the IC on 17 November 1998. All other fish were transferred 26 January 1999. At prerelease fish in MI raceways were significantly smaller than fish in OR raceways (Table 27). Marking information is presented in Table 30 and Appendix Table A-6. Most all fish reared in both MI and OR raceways were judged to be intermediately smolted. Fish were more partially descaled in MI than OR raceways. Coded-wire tag retention in MI and OR raceways ranged from 99.4-100.0 %. Food conversion ratios (lb feed/lb fish) for MI and OR raceways ranged from 1.63-1.85 and 1.38-1.43. Overall it averaged 1.61. Based on the production of 21,335 pounds; total cost including CWT was $0.25 per smolt.

Recovery data from PIT-tagged fish is presented in Table 31 and Appendix Table A-11. Percent first time detection at all sites was not significantly different ($P<0.05$) for spring released yearlings reared in MI and OR raceways. Fish reared in OR raceways and releases in the Fall had much longer migration time and lower detection. The mean FL of all fish at tagging was similar to the mean FL at tagging of fish detected at JD and BN Dams.

Adult Survival Studies: CWT recovery data is presented in Table 32. Estimated number of jacks and adults recovered from BFH 1991-94 brood years were greater than those from UFH. An unknown number of mini-jacks from both MI and OR releases (<380 mm) returned to TMFD.

Carson National Fish Hatchery:

Juvenile Rearing and Survival Studies: Eggs and fry from Carson stock were collected at CNFH and ponded into one raceway in January 1998. They were split into three standard raceways in the third week of May 1998 for final rearing at an average of 66 fish/gpm. Tag retention of CWT fish was 98.1%. Fish transferred to IC on 10 March were judged to be 98% intermediate in smolt development and 1 and 51% were descaled and partially descaled. Average length, weight, and condition factor were 129.6 mm, 26.7 g and 1.19 at transfer and 140.0 mm, 34.2 g, and 1.19 at release. Mark and recovery data of PIT-tagged fish is presented in Tables 31. These fish were detected from 20 April

through 21 May and 28 May through 2 July at JD and BN dams. The mean FL of all fish at tagging was similar to the mean FL at tagging of fish detected at JD and BN Dams.

***Adult Survival Studies**:* Adult returns will be completed in 2003. An unknown number of mini-jacks returned to TMFD in 1999.

Little White Salmon Fish Hatchery:

***Juvenile Rearing and Survival Studies**:* Eggs were collected from Carson stock at South Fork Walla Walla facility and incubated at UFH to standardize eyeing. Eyed embryos were transported to LWSFH in October 1997. Fingerlings were ponded for final rearing in standard raceways with each coded-wire tagged group divided equally among 5 raceways. Tag retention of CWT fish was above 98.0% for both release groups. Fish were transferred to IC on 18 February and 9 March 1999 and released on 8 March and 14 April. Smolt development for the both releases was judged to be all intermediate with no or partially descaled fish for the first release and 1.0 and 4.8 % descaled and partially descaled for the second release. At JD and BN dams the first release group was detected from 23 April through 16 May and 23 April through 14 May and the second release group was detected from 22 April through 21 May and 1-23 May. The mean FL of all fish at tagging was similar to the mean FL at tagging of fish detected at JD and BN Dams. Percent first time detection at all sites was not significantly different ($P<0.05$) for yearlings reared at UFH and the first release at LWSFH. Also, there was no significant difference ($P<0.05$) in first time detection percent between fish from CNFH and the second release from LWSFH.

***Adult Survival Studies**:* Adult returns will be completed in 2003. An unknown number of mini-jacks returned to TMFD in 1999.

Adult Returns to the Umatilla River

Fish counts at TMFD from 1999 and vital statistics from 1995-99 to TMFD are presented in Tables 33-34 and Appendix Table A-8. The 1999 adult and jack runs began on 15 April and 3 May, peaked 21 May and 1 June, and ended 12 July and 1 July (Figure 3).

Fishery

Catch and harvest for the sport fishery for spring chinook salmon was low in both sections (Table 35). Anglers were mostly from Umatilla and Morrow counties (94.0%) with less than 1.0% from out of state. The fishing was 99% bait and lures with 1% flies. Chinook salmon anglers harvested 5 and 119 rainbow trout (expanded) in the lower and upper river. Only 21 of the harvested trout were adipose clipped hatchery steelhead.

Discussion

Subyearlings

This strategy was discontinued at UFH because of low SAS.

Fall Release

The SAS for this strategy is below the 0.4% goal (CTUIR and ODFW 1990) for UFH. The 1993 BY had the same SAS as spring-released yearlings. It is unclear what effect size and release time have on SAS. Production was limited by space and water dedicated to yearling production. However, production may be reevaluated if SAS improves.

Yearlings

Yearling SAS from UFH is well below the 0.75% goal (CTUIR and ODFW 1990). The SAS for yearlings reared at UFH is consistently poorer than it is for yearlings reared at BFH. We have recommended reducing the size of release to mimic BFH and increase SAS. Yearling fish at UFH are reduced to 10-15 fish/lb by incubating embryos in chilled water and over wintering them at the acclimation facility. Only juvenile information is currently known. In 1998 freezing prevented over wintering at IC and two OR raceways were released in the early December.

Rearing profiles in MI and OR raceways at UFH have been evaluated for four brood years. The 1997 BY reared at lower densities in OR raceways tended to be bigger at prerelease. However, there is no trend in prior BY's. Overall descaling tended to be higher in MI raceways in earlier brood years, where scrapping on baffles may have caused more descaling especially at higher densities. Since the 1996 BY baffles have been removed. Water quality is within acceptable limits within both MI and OR raceways. We discontinued weekly monitoring in 1999.

Detection of PIT-tagged fish at JD and BN dams has replaced other marks that monitor juvenile migration. Fish reared in MI and OR raceways had similar total first-time detection at all sites and migration and median travel time to JD and BN dams, except fewer fall released OR reared fish were detected and had longer migration.

The earliest transfer of fish from LWSFH released with UFH fish were smaller than the release goal. Maximum loading was similar but water quality was different. The later transfer of fish was within the release goal. The migration and median travel time to JD and BN dams for LWSFH fish released earlier were slightly lower and longer than fish released bigger and later. Jacks from similar releases from LWSFH (1996 BY) have returned to TMFD indicating successful ocean migration.

Fish from CNFH were within release size goals and reared at same densities as LWSFH. They were released with the later LWSFH fish and were detected similarly. Jacks from similar releases from LWSH (1996 BY) have returned to TMFD indicating successful ocean migration.

A preferred release size or time could not be determined from releases in 1999 and it is unclear how disease, river condition, and acclimation time affects survival. We recommend continued monitoring of size- and time-at-release to evaluate and improve survival.

Adult Returns to the Umatilla River

The 1999 return of 1,974 jacks and adults was above the 8 year average of 1,207. Returns are well below the master plan goal of 10,000 hatchery adults. The run consisted mostly of age four adults produced from yearlings reared at UFH. The 1998 adult prediction (731), based on number of

returning jacks, greatly underestimated the actual return of 1,764 in 1999. The underestimate made broodstock collection and sport fishery more conservative than previous years. The run prediction relied on adult numbers to BN dam. Returning jacks in 1999 predict 3,409 adults for 2000.

Fishery

Low catch and harvest in the lower river may have been caused by low fishing effort, high flows, and faster migration of fish before the season. Increased effort in the upper river produced greater catch but well below the harvestable goal of 200 for the 1999 run. Recommendations to improve sport harvest for the 2000 season, if applicable, would be to open the season earlier and open fishing below TMFD.

Table 22. Exploitation and survival of spring chinook salmon reared at Umatilla and Bonneville hatcheries, coded-wire-tagged (CWT) and released in the fall in the Umatilla River, 1990-93 broods. Recoveries include age 3 and older fish. Brood years 1991-93 data are complete, other broods are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January, 2000.

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
			Umatilla Hatchery			
1991						
071542	O3B	0	0.0	0.00	0.00	0
071543	O3A	3	0.0	0.01	0.01	6
Total/Average		3	0.0	0.01	0.01	6
1992						
070159	M2A	3	0.0	0.01	0.01	4
070160	M3A	4	0.0	0.01	0.01	6
070161	M2B	0	0.0	0.00	0.00	0
070162	M3B	9	0.0	0.03	0.03	12
070163	M3C	2	0.0	0.01	0.01	3
070216	M2C	4	0.0	0.01	0.01	5
Subtotal/Average		22	0.0	0.01	0.01	28
070155	O2A	3	0.0	0.01	0.01	3
070156	O3B	0	0.0	0.00	0.00	0
070157	O2B	0	0.0	0.00	0.00	0
070158	O3B	4	0.0	0.01	0.01	5
Subtotal/Average		7	0.0	0.01	0.01	8
Total/Average		29	0.0	0.01	0.01	38
1993						
070724	M2C	15	0.0	0.04	0.04	17
070725	M3C	19	0.0	0.05	0.05	20
070726	M2B	23	0.0	0.07	0.07	25
070727	M3B	15	0.0	0.04	0.04	16
070728	M2A	11	0.0	0.03	0.03	12
070729	M3A	12	0.0	0.03	0.03	14
Subtotal/Average		95	0.0	0.04	0.05	104

[a] *Expanded CWT recoveries.*

Table 22 (continued)

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1993						
070730	O2A	27	0.0	0.07	0.08	28
070731	O1A	28	0.0	0.08	0.08	29
070732	O2B	20	0.0	0.06	0.06	20
070733	O1B	28	0.0	0.08	0.08	28
Subtotal/Average		103	0.0	0.07	0.07	105
Total/Average		198	0.0	0.06	0.06	209
			Bonneville Hatchery			
1991						
076042	A11	15	6.7	0.06	0.06	15
076043	A10/A11	12	25.0	0.04	0.05	12
076044	A10	5	0.0	0.03	0.03	5
076045	A9	12	0.0	0.05	0.05	12
076046	A8/A9	20	0.0	0.08	0.08	20
076047	A8	8	0.0	0.05	0.05	8
Total/Average		72	5.3	0.05	0.05	72

Table 23. Egg-take and survival of yearling spring chinook salmon reared at Umatilla Hatchery, 1991-97 broods. All eggs are Carson stock.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry survival (%)	Egg-to-smolt survival (%)[a]
Carson NFH	1991	332,000	97.2	93.4
Carson NFH	1992	319,000	71.3	67.4
Carson NFH	1993	314,000	66.6	61.8
Ringold/Lyons Ferry	1994	602,000	71.8	58.8
Carson NFH, Lyons Ferry/ Little White Salmon	1995	226,000	96.3	
Little White Salmon, Umatilla, Carson NFH	1996	487,612	80.2	78.6
Little White Salmon, Umatilla, Carson NFH	1997	507,006	79.3	72.8

[a] *Survival is based on numbers of green eggs and smolts released.*

Table 24. Water quality measurements in Michigan raceways that reared yearling spring chinook salmon from 1992-98 at Umatilla Fish Hatchery. Means with different letters indicate significant differences ($P < 0.05$). First letter indicates difference among passes and second indicates difference between inlet and outlet within passes.

		Inlet			Outlet		
Parameter	Pass	N	Means	Min-Max	N	Means	Min-Max
Temperature	A	89	13.9a x	11.4-16.3	89	13.9a x	11.4-16.1
(°C)	B	89	13.9a x	11.4-16.4	89	14.0a x	11.4-16.6
	C	57	13.9a x	11.2-16.1	57	14.0a x	11.2-16.3
pH	A	83	7.84a x	6.64-8.70	83	7.80a x	6.65-8.65
	B	83	7.82a x	6.67-8.65	83	7.80a x	6.66-8.65
	C	51	7.79a x	6.63-8.17	51	7.76a x	6.65-8.20
Oxygen	A	85	11.10a x	7.9-13.7	84	9.70a y	7.3-11.8
(mg/L)	B	85	10.96a x	8.8-13.7	85	9.68a y	7.9-11.8
	C	54	10.69b x	8.5-14.0	53	9.49a y	7.3-11.7
Unionized	A				62	0.33a	0.02-1.35
Ammonia	B				62	0.55b	0.02-2.56
(µg/l)	C				30	0.58b	0.03-1.42

Table 25. Water quality measurements in Michigan and Oregon raceways that reared yearling spring chinook salmon from 1992-98 at Umatilla Fish Hatchery. Means with different letters indicate significant differences ($P < 0.05$) between comparisons of A and B passes combined.

		Inlet			Outlet		
Parameter	System	N	Means	Min-Max	N	Means	Min-Max
Temperature	MI	178	13.9x	11.4-16.4	178	13.9x	11.4-16.1
(°C)	OR	352	13.5y	10.4-16.4	352	13.6y	11.4-16.6
pH	MI	166	7.83x	6.64-8.70	166	7.80x	6.65-8.65
	OR	334	7.89y	6.63-8.77	334	7.88y	6.67-8.76
Oxygen	MI	170	11.03x	7.9-13.7	169	9.69x	7.3-11.8
(mg/L)	OR	344	10.00y	7.5-14.5	344	8.85y	4.6-14.7
Unionized	MI				124	0.44x	0.02-2.56
Ammonia	OR				274	0.51y	0.01-6.01
(µg/l)							

Table 26. Rearing conditions for yearling spring chinook salmon in Michigan or Oregon raceways at Umatilla, Bonneville, Little White Salmon, and Carson hatcheries, brood years 1991-97.

Brood year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)	Total number reared per gpm in system
		Umatilla Hatchery		
1991	Oregon	1.0	5.0	83
1992	Oregon	1.0	4.8-5.0	84
1993	Oregon	0.9-1.1	4.6-5.4	74
1994	Michigan	2.4-2.7	5.9-6.6	115
	Oregon	1.2-1.3	5.6-6.2	94
1995	Oregon	1.0	4.8-4.9	92
1996	Michigan	2.0	4.9	164
	Oregon	0.9	4.2	91
1997	Michigan	3.5	8.4	157
	Oregon	0.7-1.3	3.2-6.2	46
		Bonneville Hatchery		
1991	Oregon	0.8	5.5-5.6	65-66
1992	Oregon	1.6-1.7	11.0-11.5	142-149
1993	Oregon	1.1-2.0	7.3-13.6	107-178
		Little White Salmon Hatchery		
1996		1.6-1.9	5.0-6.0	81-91
1997		1.6-2.0	4.5-5.7	65-94
		Carson National Fish Hatchery		
1996		1.6	5.3	114
1997		1.3	4.0	68

Table 27. Mean length, weight, and condition factor for yearling spring chinook salmon reared in Michigan and Oregon raceways at Umatilla Hatchery during 1998-99, 1997 brood. Means with the same first letter are not significantly different (P>0.05) among passes within MI or OR raceways. Means with the same second letter are not significantly different (P>0.05) between OR and MI raceways of combined A and B passes.

		Length(mm)		Weight(g)		Condition Factor	
Sample	Pass	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
				Michigan			
August:	A	100	83.8(0.6)	57	8.0(0.2)	57	1.38(0.01)
	B	105	85.6(0.5)	46	8.5(0.3)	46	1.38(0.01)
	C	110	85.2(0.5)	54	8.9(0.2)	54	1.41(0.01)
September:	A	97	99.7(0.5)	55	14.9(0.4)	55	1.43(0.01)
	B	103	100.1(0.5)	49	14.3(0.4)	49	1.42(0.01)
	C	99	100.1(0.6)	48	14.6(0.4)	48	1.40(0.01)
October:	A	101	111.5(0.7)	60	18.9(0.4)	60	1.36(0.01)
	B	101	111.5(0.7)	97	18.5(0.4)	97	1.32(0.01)
	C	106	111.0(0.7)	53	19.1(0.5)	53	1.35(0.01)
November:	A	99	116.3(0.9)	54	21.4(0.7)	54	1.30(0.01)
	B	102	118.7(0.8)	54	22.2(0.7)	54	1.29(0.02)
	C	113	118.5(0.7)	70	22.4(0.5)	70	1.31(0.01)
Pre-release:	A	256	131.2(0.6)a x	113	28.0(0.7)a x	113	1.23(0.01)a x
	B	256	131.6(0.6)a	102	28.1(0.6)a	102	1.23(0.01)a
	C	259	132.6(0.6)a	112	28.8(0.7)a	103	1.20(0.01)a

Table 27 (continued)

Sample	Pass	Length(mm) N	Length(mm) Mean(SE)	Weight(g) N	Weight(g) Mean(SE)	Condition Factor N	Condition Factor Mean(SE)
			Oregon				
June:	A	128	53.3(0.3)	73	2.0(0.1)	73	1.29(0.02)
July:	A	126	72.5(0.3)	57	5.2(0.1)	57	1.31(0.01)
August:	A	209	86.1(0.3)	110	8.9(0.2)	110	1.38(0.01)
	B	206	85.2(0.3)	112	8.6(0.1)	112	1.36(0.01)
September:	A	221	102.2(0.4)	110	15.0(0.3)	110	1.39(0.01)
	B	224	100.3(0.4)	132	13.9(0.2)	132	1.38(0.01)
October:	A	208	112.9(0.4)	100	19.3(0.4)	100	1.33(0.01)
	B	207	113.5(0.5)	109	19.7(0.3)	109	1.33(0.01)
November:	A	109	119.9(0.7)	49	22.5(0.6)	49	1.32(0.01)
	B	111	120.6(0.7)	48	22.3(0.6)	48	1.27(0.01)
Pre-release:	A	262	109.1(0.4)a y	102	15.9(3.1)a y	102	1.20(0.01)a x
10/14/99	B	251	107.5(0.3)a	106	15.5(2.7)a	106	1.21(0.01)a
Pre-release:	A	256	138.6(0.7)a y	101	33.9(0.8)a y	101	1.24(0.01)a x
01/20/00	B	255	137.3(0.6)a	101	32.9(0.6)a	101	1.22(0.01)a
			Combined Release[a]				
		620	141.6(0.5)	229	33.6(0.6)	229	1.16(0.00)

[a] *Fish were sampled from three acclimation ponds on 8 March, 1999.*

Table 28. Mean length, weight, and condition factor at pre-release for yearling spring chinook salmon reared in Michigan or Oregon raceways at Umatilla Hatchery, 1991-97 broods (standard error in parentheses).

Brood year	System	Length (mm)	Weight (g)	Condition factor
1991[a]	Oregon	158.8(0.0)	50.5(0.0)	1.20(<0.01)
1992	Oregon	163.0(0.7)	55.2(1.3)	1.23(0.01)
1993[b]	Michigan	166.9	57.8	1.24
	Oregon	171.0	56.9	1.16
1994[b]	Michigan	160.9	46.4	1.11
	Oregon	167.7	53.0	1.12
1995[b]	Oregon	149.2	45.9	1.35
1996	Michigan	147.1(0.4)	39.9(0.5)	1.21(<0.01)
	Oregon	145.9(0.3)	40.0(0.5)	1.25(<0.01)
1997	Michigan	131.8(0.4)	28.3(0.4)	1.22(<0.01)
	Oregon(10/15/1998)	108.3(0.3)	15.7(0.2)	1.21(<0.01)
	Oregon(1/20/1999)	137.9(0.4)	33.4(0.5)	1.23(<0.01)

[a] *Brood years 1991-92 were not acclimated and were released directly into the Umatilla River.*
[b] *Fish from the 1993 through 1995 brood years were measured at release after acclimation, standard errors were not determined.*

Table 29. Percent descaled, partially descaled, and undamaged yearling spring chinook salmon reared in Michigan and Oregon raceways at Umatilla Hatchery, brood years 1991-97.

Brood year	System[a]	Descaled[b]	Partially descaled[c]	Undamaged[d]
1991	Oregon	1.0	1.0	99.0
1992	Oregon	1.0	18.0	81.0
1993	Michigan	3.0	24.0	74.0
	Oregon	0.0	15.0	85.0
1994	Michigan	13.0	54.0	33.0
	Oregon	1.0	12.0	87.0
1995	Oregon	1.0	13.0	86.0
1996	Michigan	0.0	17.0	83.0
	Oregon	1.0	24.0	76.0
1997	Michigan	3.0	53.0	44.0
	Oregon(10/15/1998)	0.0	0.0	100.0
	Oregon(1/20/1999)	1.0	87.0	12.0

[a] *Data are mean of A and B passes.*

[b] *More than 20 % descaling on either side of the fish.*

[c] *Descaling = 3 to 20 % on either side of the fish.*

[d] *Less than 3 % descaling on either side of the fish.*

Table 30. Tag and mark information for yearling spring chinook salmon reared at Umatilla, Little White Salmon, and Carson fish hatcheries and released in the Umatilla River in 1999, 1997 brood. (CWT = coded wire tag).

Raceway and PTAGIS PIT-tag file	Release date	CWT code	Number recognizably CWT and clipped[a]	Number PIT-tagged fish released	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
			Umatilla Hatchery				
O4A (WAC98288.O4A)	12/20/1998	092414	21,795	243	6.5	0.0	61,849
O4B (WAC98288.O4B)	12/20/1998	092416	21,969	240	4.4	0.4	52,521
M2A (WAC99019.M2A)	03/08/1999	092347	20,893	240	6.3	0.0	49,189
M2B (WAC99019.M2B)	03/08/1999	092411	21,803	247	2.4	0.4	48,901
M2C (WAC99019.M2C)	03/08/1999	092412	21,908	240	7.3	0.0	51,018
O5A (WAC99020.O5A)	03/08/1999	092413	21,673	241	4.3	0.4	53,403
O5B (WAC99020.O5B)	03/08/1999	092415	21,792	233	7.1	0.0	51,320
			Little White Salmon Hatchery				
39-43 (WAC99049.IM1)	03/08/1999	076037	17,730	248	1.6	0.0	194,326
35-38 (WAC99069.IM2)	04/14/1999	076038	19,974	219	12.1	2.7	156,707
			Carson Hatchery				
37-40 (WAC99069.CAR)	04/14/1999	075746	20,056	248	2.7	1.2	103,761

[a] *All fish with CWT were adipose fin-clipped*

Table 31. Number and percent detected, median travel time, and median passage date at John Day and Bonneville dams for PIT-tagged yearling spring chinook salmon released in the Umatilla River, spring 1999.

		John Day			Bonneville		
Raceway	CWT code	Percent detected (number)	Median travel time (d)	Median passage date	Percent detected (number)	Median travel time (d)	Median passage date
			Umatilla Hatchery[a]				
M2A	092347	10.4(25)	46	4/23/1999	3.8(9)	51	4/29/1999
M2B	092411	15.4(38)	46	4/23/1999	4.9(12)	48	4/26/1999
M2C	092412	15.4(37)	45	4/22/1999	6.3(15)	49	4/27/1999
O4A	092414	4.1(10)	130	4/30/1999	0.8(2)	127	4/27/1999
O4B	092416	3.3(8)	125	4/25/1999	1.3(3)	132	5/2/1999
O5A	092413	14.9(36)	45	4/22/1999	6.6(16)	48	4/26/1999
O5B	092415	15.9(37)	46	4/23/1999	7.3(17)	50	4/28/1999
			Little White Salmon Hatchery[a]				
39-43	076037	8.5(21)	57	5/4/1999	3.6(9)	56	5/4/1999
35-38	076038	14.7(32)	29	5/13/1999	5.5(12)	31	5/15/1999
			Carson Hatchery[a]				
37-40	075746	18.1(45)	31	/515/1999	5.2(13)	34	5/18/1999

[a] *Fish from Umatilla Hatchery and raceway 46 from Little White Salmon Hatchery were released on 8 March 1998; Fish from Carson Hatchery and raceway 48 from Little White Salmon Hatchery were released on 14 April 1998.*

Table 32. Exploitation and survival of yearling spring chinook salmon that were reared at Umatilla and Bonneville hatcheries, coded-wire-tagged (CWT) and released in the Umatilla River, 1991-96 broods. Recoveries include age 3 and older fish. Brood years 1991-2 are complete, other brood years are incomplete. Estimates of number of jacks and adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
			Umatilla Hatchery			
1991						
075739	O5B	3	0.0	0.01	0.01	7
075740	O4B	3	0.0	0.01	0.01	7
075741	O4A	16	0.0	0.08	0.08	41
075742	O5A	8	0.0	0.04	0.04	21
Total/Average		30	0.0	0.04	0.04	76
1992						
070217	O5A	0	0.0	0.00	0.00	0
070218	O5B	14	0.0	0.07	0.07	35
070219	O4B	9	0.0	0.04	0.04	23
070220	O4A	22	4.5	0.10	0.11	54
Total/Average		45	1.5	0.05	0.05	112
1993						
071453	M5A	4	0.0	0.02	0.02	7
071454	M5B	10	0.0	0.06	0.06	26
Subtotal/Average		14	0.0	0.04	0.04	33
070651	O4A	4	0.0	0.02	0.02	10
070652	O4B	8	0.0	0.04	0.04	19
070653	O5B	18	0.0	0.10	0.10	39
070654	O5A	1	100.0	0.00	0.01	0
Subtotal/Average		31	25.0	0.04	0.04	68
Total/Average		45	16.7	0.04	0.04	101
1994						
071027	M6A	1	0.0	0.01	0.01	2
071028	M6B	0	0.0	0.00	0.00	0
071029	M6C	0	0.0	0.00	0.00	0
Subtotal/Average		1	0.0	0.00	0.00	2

[a] *Expanded CWT recoveries.*

Table 32. (continued)

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1994						
071030	O4A	0	0.0	0.00	0.00	0
071031	O5A	0	0.0	0.00	0.00	0
071032	O5B	3	0.0	0.01	0.01	9
071033	O4B	0	0.0	0.00	0.00	0
Subtotal/Average		3	0.0	0.00	0.00	9
Total/Average		4	0.0	0.00	0.00	11
1995						
091730	O4A	1	0.0	0.01	0.01	3
091749	O5A	5	0.0	0.03	0.03	14
091750	O4B	3	0.0	0.01	0.01	8
091751	O5B	0	0.0	0.00	0.00	0
Total/Average		9	0.0	0.01	0.01	25
1996						
092256	M2A	0	0.0	0.00	0.00	0
092257	M2B	0	0.0	0.00	0.00	0
092258	M2C	0	0.0	0.00	0.00	0
Subtotal/Average		0	0.0	0.00	0.00	0
092259	O5A	0	0.0	0.00	0.00	0
092260	O4A	0	0.0	0.00	0.00	0
092261	O5B	0	0.0	0.00	0.00	0
092262	O4B	0	0.0	0.00	0.00	0
Subtotal/Average		0	0.0	0.00	0.00	0
Total/Average		0	0.0	0.00	0.00	0
Bonneville Hatchery						
1991						
071455	B1	45	6.7	0.21	0.23	102
071456	B2	33	9.1	0.15	0.17	76
Total/Average		78	7.9	0.18	0.19	178
1992						
070250	B6	142	1.4	0.52	0.53	529
070251	B5	140	5.7	0.50	0.53	538
075944	B8	113	2.7	0.54	0.56	584
075945	B7	80	2.5	0.39	0.40	394
Total/Average		475	3.1	0.51	0.50	2,045

Table 32. (continued)

Brood year, CWT code	Raceway	N[a]	Total exploit-tation (%)	Umatilla return rate (% of release)	Total survival rate(% of release)	Number of jacks and adults recovered
1993						
070649	B7	146	0.0	0.65	0.66	805
070650	B8	160	0.0	0.66	0.66	828
070660	B5	82	6.1	0.32	0.35	247
070661	B6	168	1.8	0.57	0.58	430
Total/Average		556	1.9	0.55	0.56	2,310

Table 33. Number of spring chinook salmon that returned to the eastbank fish ladder, Three-Mile Falls Dam, Umatilla River, 1995-99.

	Male		Female		Unknown		Total	
Age[a]	Number	%	Number	%	Number	%	Number	%
				1995				
Subjack	26	100.0	0	0.0	0	0.0	26	5.2
Jack	82	100.0	0	0.0	0	0.0	82	16.5
Adult	162	41.8	224	57.7	2	0.0	388	78.2
Total	270	54.4	224	45.2	2	0.4	496	100.0
				1996				
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	121	100.0	0	0.0	0	0.0	121	5.3
Adult	948	44.1	1,204	55.9	0	0.0	2,152	94.7
Total	1,069	47.0	1,204	53.0	0	0.0	2,273	100.0
				1997				
Subjack	0	0.0	0	0.0	0	0.0	2	0.0
Jack	4	100.0	0	0.0	0	0.0	4	0.2
Adult	968	44.2	1,223	55.8	0	0.0	2,192	99.7
Total	972	44.3	1,223	55.6	1	0.1	2,198	100.0
				1998				
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	20	100.0	0	0.0	0	0.0	20	4.7
Adult	200	48.9	209	51.1	0	0.0	409	95.3
Total	220	51.3	209	48.7	0	0.0	429	100.0
				1999				
Subjack	0	0.0	0	0.0	0	0.0	0	0.0
Jack	206	100.0	0	0.0	0	0.0	206	10.4
Adult	749	42.4	1,019	57.6	0	0.0	1,768	89.6
Total	955	48.4	1,019	51.6	0	0.0	1,974	100.0

[a] *Age designation based on fork length: subjacks <381 mm, jacks 382-610 mm, adults >610 mm).*

Table 34. Vital statistics of spring chinook salmon that returned to the east-bank fish ladder, Three Mile Falls Dam, Umatilla River in 1999 by release strategy and hatchery. Data was determined from CWT recovery (sex was determined visually).

Brood year	Age	Number	Sex	Fork length (mm) mean	min	max
			Umatilla Hatchery			
1995	4	143	male	790	650	885
		251	female	756	636	850
1996	3	66	male	550	485	615
			Carson National Hatchery			
1996	3	2	male	555	505	605
			Little White Salmon Hatchery			
1996	3	5	male	563	530	590

Table 35. Estimated catch statistics for spring chinook salmon in the Umatilla River in 1999. Lower river = Three Mile Falls Dam to Yoakum Bridge. Upper River = Yoakum Bridge to the lower boundary of the Confederated Tribes of the Umatilla Indian Reservation. Number caught and number harvested includes ± 95% confidence interval.

Month Day type	Number sampled days	 anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
			Lower River			
May						
Weekend/						
Holiday	2	12	15.4	0	0	0
Total	2	12	15.4	0	0	0
June						
Weekday	0	0	0	0	0	0
Weekend/						
Holiday	2	6	5.7	0	0	0
Total	2	6	5.7	0	0	0
Lower River						
Total	4	18	21.1	0	0	0
			Upper River			
May						
Weekend/						
Holiday	3	95	230.1	3	2	0.01
Total	3	95	230.1	3	2	0.01
June						
Weekday	8	68	174.7	3	2	0.02
Weekend/						
Holiday	5	59	126.5	0	0	0
Total	13	127	301.2	3	2	0.02
Upper River						
Total	16	222	531.3	6	4	0.01

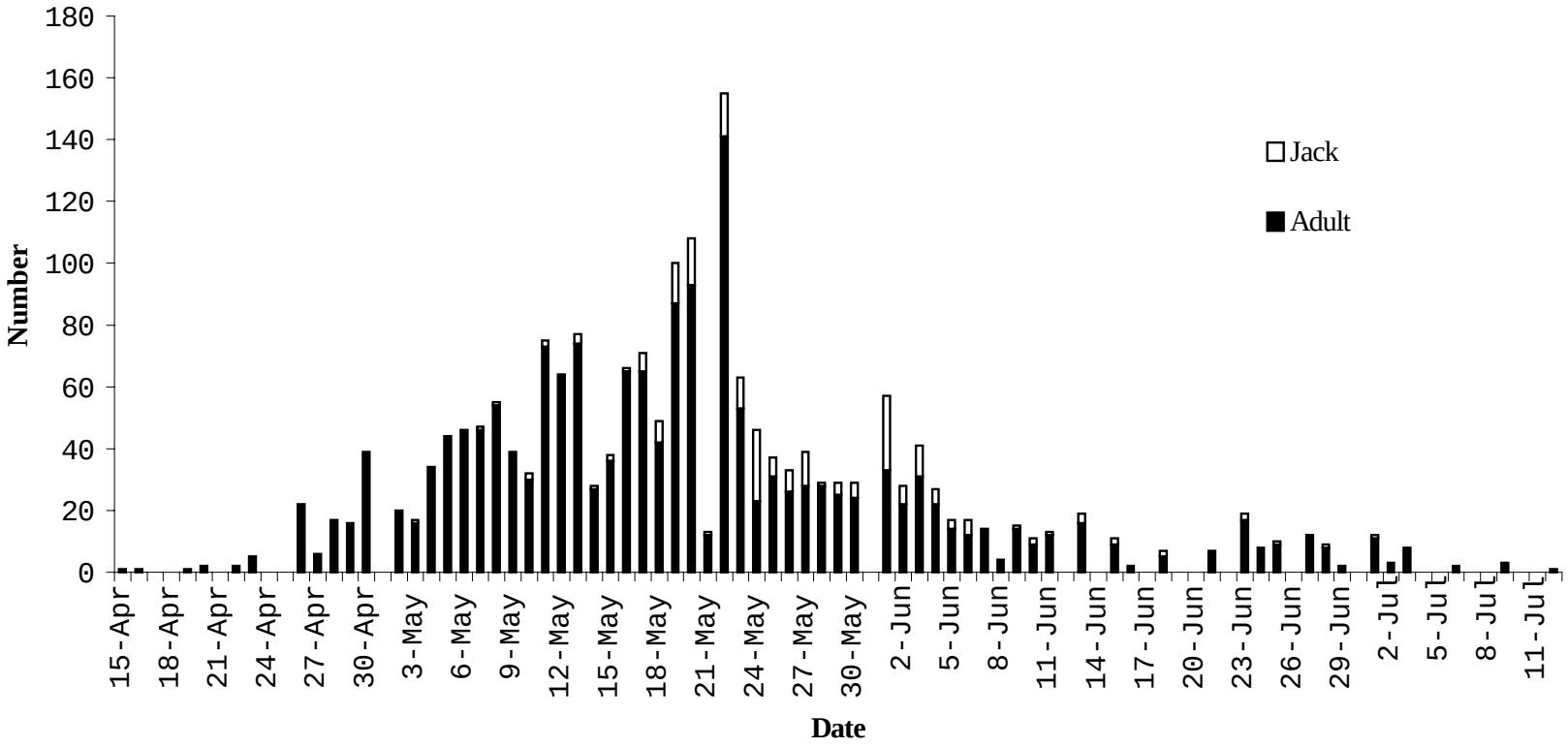

Figure 3. Numbers of jack, and adult spring chinook salmon counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1999.

SUMMER STEELHEAD

Overview

The objective of the steelhead rearing evaluation is to monitor rearing conditions, cost, migration, and SAS for steelhead produced in the MI system and compare these parameters among MI passes. Eight steelhead broods (1991-98) have been reared in MI raceways at UFH and released in the Umatilla River (Appendix Table A-7). Comparisons are being made with Imnaha and Wallowa stock steelhead reared in OR raceways at Irrigon Fish Hatchery. The original production goal of 210,000 fish was reduced to 150,000 fish after the first brood (1991) because high densities appeared to cause poor fish condition. Adult return data will be complete in 2002.

Methods

Juvenile Rearing and Survival Studies

Methods in rearing and survival studies and PIT-tagging were the same as described for subyearling fall chinook salmon except PIT-tagging rates were 300 fish in the B- and C-passes and 600 in the A-pass.

We used radio telemetry and snorkeling to monitor migration of small-grade steelhead smolts from BS. Various studies have used radio telemetry to confirm individual fish movement including: Moser et al. (1991) and Isaak and Bjorn (1996). The objectives of this pilot study were to describe juvenile migration patterns in the Umatilla River and determine whether radio telemetry is a practical method to monitor steelhead outmigration.

A sub-sample of 20 individuals were each implanted with uniquely coded Lotek mini transmitters (Model MCFT-3HM) and released after 24 h recovery into Boston Canyon Creek at the BS outlet on 5 May 1999. Since transmitter weight should not exceed 3% of body weight, only healthy fish greater than 100 g were tagged. Transmitters were 9 x 20 mm with a 300 mm antenna, weighed three grams, transmitted a radio frequency of 149.60 MHz at burst rate of 5 s, and had a 44 day operational life. Procedures for radio tag implantation followed methods outlined by Blaine Bellerude (1999, ODFW) and Eric Hochersmith (1999, National Marine Fisheries Service).

Movement of tagged fish was monitored with three stationary radio-receivers, Lotek SRX-400 receiver/data logger with code programmed, and one mobile tracking receiver, Lotek SRX 400 with scan program. Stationary receivers were located at Stanfield Dam (RM 32.5), Westland Dam (RM 27.3), and Interstate 82 bridge (RM 1.2). Each stationary receiver had a 6-element Yagi antenna angled downstream and upstream that continually scanned 149.60 MHz and recorded receptions every minute. Effective range of antennas were approximately 200 meters. Data was downloaded once a day. Mobile tracking systems consisted of a 6-element Yagi antenna mounted horizontally on 7 ft pole in the bed of a pick-up truck. Receptions were recorded manually. The antenna was pointed towards the river during tracking. Effective range of the antenna was one quarter mile. We began biweekly mobile tracking 24 h after tagged fish were released. We tracked along access roads from Stanfield Dam upstream two miles above BS on Meacham Creek and from the mouth of Meacham Creek to the USGS gauging station on the Umatilla River (RM 81). Approximately 10% of this area was

inaccessible. Data collected by stationary and mobile tracking receivers included tag code, location, time, and signal strength.

Movement of hatchery steelhead from BS releases were monitored by snorkel surveys in pools at BS outlet, river mile one Meacham Creek, river miles 79 and 80 of the Umatilla River. One person snorkeled upstream from pool tail until riffles prevented snorkeling and counted all fish and estimated lengths. Counts were only accepted if the clarity was > 5 m. Density was determined by dividing number by pool surface area (m^2).

Adult Survival Studies

Methods to collect data on steelhead returns and survival estimates were the same as described for fall chinook salmon. Adult recovery data was downloaded from the PSMFC database in March 2000. Parent-progeny and parent-fishery escapement ratios were calculated as the total number of adult progeny and estimated fishery escapement divided by the number of brood spawned, respectively. Total number of adults produced was estimated as the sum of all coded-wire-tag recoveries at and below TMFD expanded for marking and sampling rate and corrected to the actual number of hatchery fish counted at TMFD. Fishery escapement was estimated as the number of fish to TMFD minus numbers of fish removed from the run at and above TMFD (broodstock collection, coded-wire-tag sampling, mortality, and fishery harvest). Proportional representation of CWT groups within the run was based on collection of 88-166 CWT's per year at TMFD and in the Umatilla River sport fishery below TMFD.

Adult Returns to the Umatilla River

Methods to calculate adult returns were the same as described for subyearling fall chinook salmon. All adult steelhead trapped at TMFD were classified as one or two ocean fish based on a 660 mm fork length cutoff for the two age groups. Estimation of numbers and proportional representation of endemic and nonendemic hatchery steelhead in the run followed methods described above.

Fishery

Except for the following modifications, methods to survey the steelhead sport fishery in 1998-99 were described in previous annual reports. The steelhead fishery was open from 1 September 1998 to 15 April 1999. Thirty-five days were not fishable because of high water. Angling was allowed from the Umatilla mouth to the lower CTUIR boundary upstream of Pendleton. Creel surveys were focused in areas of the river with the easiest public access and at times of highest angling effort. These were the lower river (TMFD to river mouth) during the fall salmon and steelhead fishery and the upper river (Barnhart Bluffs at river mile 42 to lower CTUIR boundary at river mile 55) during the winter and spring steelhead fishery. Lower river surveys were completed on 26 November 98 and upper river surveys were initiated on 7 January 99. Rainbow trout over 20 inches in length were indistinguishable from natural steelhead. The legal harvest limit was 2 adipose-clipped steelhead per day and 20 for the season.

Statistical Analyses

Methods to analyze data were the same as those used for fall chinook salmon.

Results

Juvenile Rearing and Survival Studies

Data on juvenile rearing and survival is presented in Tables 36-41 and Appendix Table A-7. Steelhead from the 1998 brood were ponded in one OR raceway on 1 September 1998 at 258 fish/lb. In November fish were graded into smalls (> 30 fish/lb) and larges ≤ 30 fish/lb) and the smalls were ponded into pass A and the larges into pass B and C. All passes were marked with CWTs and all fish were adipose fin clipped by mid-November. Dry feed conversion ratios (fish feed per pound of fish produced) are presented in Table 37. Based on the production of 22,608 pounds; total cost including CWT was $0.67 per smolt. With a projected survival of 0.5% a total of 1,607 adults will be produced with a value $1.34 each.

Data on fish size and condition at release is presented in Tables 41-42. Most of the steelhead were classified at release as intermediate (98.1%) and the remainder as parr (1.6%) and smolts (0.3%). Only the late-released small group had fish classified as smolts. All parr were observed in the early-released large groups.

Coded-wire-tag and PIT-tag release and recovery data is presented in Tables 43-45 and Appendix Table A-7. Coded wire tag retention ranged from 93.1-98.6 % and acceptable fin clips ranged from 99-100 %. Total first-time detections of PIT-tagged large steelhead was higher for the group released from MN (24.8%) compared with larges released from BS (16.7%). Steelhead were detected from 18 April - 21 June at JD dam and 24 April - 22 June at BN dam. Migration timing of the late-released small steelhead past JD and BN dams was approximately two and one week later than the large steelhead, respectively (Table 43). Median travel time from release to JD dam for all rearing groups was 37.7 d. Mean travel time from JD dam to BN dam was 2.0 d (N=13) for fish detected at both dams. Within each release group, larger-sized fish were more likely to be detected at JD and BN dams. Mean length at tagging of detected fish was significantly larger than the mean length at tagging of their respective size group for both large (12.6 mm larger, $P<0.05$) and small (11.8 mm larger, $P=0.002$) grade steelhead (Table 46). Percent first time detection at all sites was significantly higher ($P<0.05$) for larger-grade steelhead released from MN than for larger-grade steelhead released from BS.

Fish movement was recorded up to 50 days after radio transmitter insertion (Figure 5). After release 16 fish were detected at least one time. Six fish remained in Boston Canyon or Meacham Creek for 50 days. Three individuals were recorded by the lowest fixed station in 21, 22, and 33 days after release and assumed to have exited the Umatilla River. The individual exiting in 21 days was detected at JD (RM 216.5), The Dalles (RM 191.5), and BN (RM 146.1) dams on the Columbia River 23, 25, and 26 days after release. The remaining fish held in pools in the Umatilla River below Meacham Creek until their batteries expired. There was no significant difference ($P>0.05$) between the average weight or length of fish remaining at BS and those migrating out of the Umatilla River.

Hatchery steelhead recorded during snorkeling surveys is presented in Table 47. No radio-tagged fish were observed. Fish density decreased over time and as the distance from BS increased. We observed different fish sizes at snorkeling sites especially at BS outlet. We snorkel surveyed a few pools in Meacham Creek above BS and in the Umatilla River above the screw trap site and saw no hatchery steelhead.

Adult Survival Studies

Smolt-to-adult survival information is presented in Table 48. Early-released large steelhead consistently had higher SAS than the late-released small steelhead. Total number of adults produced from the 1992-96 broods was 1,228 for larges released at BS, 1,194 for larges released at MN, and 255 for smalls released at BS. Mean parent-progeny ratios for large and small steelhead have averaged 1:10.0 and 1:1.3, respectively (Table 49). Mean fishery escapement to the Umatilla River of the large and small groups have averaged 242 and 40 fish.

Adult Returns to the Umatilla River

Steelhead were trapped at TMFD from 17 August 1998 to 13 July 1999. Number of steelhead counted at TMFD in 1998-99 was 751 hatchery fish and 1,135 wild fish for a total of 1,886 (Table 50 and Appendix Table A-8). Vital statistics on adults and run timing are presented in Tables 50-51 and Figure 5. Composition of the run to TMFD was 60.2% wild and 39.8% hatchery fish (54 hatchery fish were harvested below TMFD). On 28 November 1998, counts peaked at 40 wild and 44 hatchery steelhead. From run years 1992-93 to 1998-99, the hatchery run has had a significantly higher percentage of males (42.0%) than the wild run (28.9%) but percent composition of one-salt fish has been similar for both runs (61.9% and 57.2%, Table 52). Non-endemic hatchery steelhead comprised 8.9% of the hatchery run and 3.6% of the combined hatchery and wild run to the mouth of the Umatilla River in 1998-99 (Table 53). They originated from Lyons Ferry Hatchery releases in the Tucannon River (tag codes: 636130 and 63637) and Irrigon Hatchery releases in the Wallowa River (071216, 091827).

Fishery

Catch and harvest data for the steelhead sport fishery is presented in Tables 54-55. Angler residency in 1998-99 (N=931) was 97.1% Umatilla and Morrow counties, 1.8% other Oregon counties, and 1.1% out-of-state. The estimated catch of 149 steelhead below TMFD consisted of 50% hatchery and 50% wild (all wild fish were released). Anglers released 20 of 74 (27%) hatchery fish caught below TMFD. Expanded CWT recoveries from 11 tags collected below TMFD by code were: 16 (091836), 4 (053212), 4 (091835), 2 (054154), and 2 (071036). The estimated catch in the upper river was 233 steelhead (25% hatchery and 75% wild). Anglers released 11 of 58 hatchery steelhead caught. Descriptive statistics for the Umatilla River steelhead fishery from the 1993-94 to 1998-99 seasons is given in Table 56. The lower-river fishery has accounted for most of the harvest (67% of the harvest and 5.8% of the hatchery run) and hatchery steelhead catch (67%). Percent of hatchery fish in the catch has been equal to their percent in the run (44%) in the lower-river fishery, but not in the upper-river fishery. In the upper river, percent of hatchery fish in the catch (29%) has averaged 15% lower than their percent in the run (44%). Wild steelhead catch has been approximately equal in the upper and lower river (8.5% of the run). Percent composition of the catch is predominantly wild steelhead in both the lower- (56%) and upper-river (71%) fisheries.

Discussion

Juvenile Rearing and Survival Studies

Determining whether oxygen supplementation can increase efficiency of water use and ultimately total hatchery production at the UFH and IFH complex is the highest evaluation priority identified in

the hatchery master plan (CTUIR and ODFW 1990). Initially a side-by-side evaluation of oxygen-supplemented (Michigan raceways) and standard (Oregon raceways) rearing systems was planned using Wallowa stock steelhead produced for release into the Grande Ronde basin. However, implementation of this evaluation was deferred because of lower than anticipated water supply. In lieu of a side-by-side evaluation, we have presented comparisons of Umatilla stock steelhead reared in Michigan raceways at UFH to Wallowa stock steelhead reared in Oregon raceways at IFH. These comparisons are weakened by stock differences, but benefit from the proximity of the two hatcheries and a shared water source.

Michigan raceways have not been as water efficient for rearing steelhead as anticipated. Initially, we tried high fish density (6 lb/ft^3) for the first steelhead brood (1991) with four water exchanges per hour in a three-pass system which yielded twice the efficiency of water use (lb/gal/min) as two-pass OR raceways at IFH. However, fish densities have since been reduced due to severe fin erosion and descaling and poor food conversion that was attributed to crowding during that initial year. Water quality was adequate during the initial year of high density rearing. Efficiency of water use for MI raceways during the seven subsequent broods has averaged only 30% higher than OR raceways. Water use efficiency has decreased because we maintained the recommended four water exchanges per hour at the lower fish densities to maintain self-cleaning dynamics in raceways (Westers et al. 1986). Our experience suggests 6 lb/ft^3 density was too high for rearing steelhead. After densities were reduced to 4 lb/ft^3, Michigan raceways performed well for rearing juvenile steelhead. Water quality remains within acceptable limits and food conversion is comparable to that observed for steelhead in OR raceways at IFH. Egg-to-smolt survival rates (57-85%) have outperformed master plan expectations (53%) and target length at release (5 fish/lb) can be met. Currently one three-pass MI raceway at 4 lb/ft^3 density meets our smolt production goal. If this goal increases or changes in hatchery operation allow a side-by-side MI and OR evaluation in the future, we recommend the addition of a fourth MI pass to achieve higher water efficiency.

The quality of juvenile migration data has been improved by PIT-tag technology. In previous years, brand and paint mark recovery rates from gatewell subsampling at JD dam were one percent or less for Umatilla steelhead and large expansion factors were used to estimate dam passage. Juvenile migration data from these early years has not corresponded with SAS. Whether PIT-tag data will be better associated with SAS is unknown. Current detection rates of 6-18% are an improvement, but are still low compared with detection rates of steelhead at other dams. PIT-tag detection rates of 50-70% are typically observed for steelhead released in the Grande Ronde Basin when they pass Lower Granite Dam (Tim Whitesel, 1999, ODFW, personal communication). It is uncertain whether low detection rates for Umatilla steelhead represent poor survival or low bypass collection efficiency at JD dam. Collection efficiency of the juvenile fish bypass at JD dam has not been adequately determined for varying species and river conditions.

We used PIT-tag data to estimate minimum survival of all tag groups to the first detection site and relative detection of tag groups with similar release and migration timing. Minimum survival to the first detection site (lower Umatilla River) was highest for larges released from MN (25%) and about equal for the large (17%) and small (16%) groups released from BS. These unexpanded differences in detection among tag groups are consistent with data expanded for bypass collection efficiency at lower Umatilla River detection site (Knapp et. al 2001). Expanded detections estimate total survival to the lower Umatilla River in 1999 at approximately three times the minimum survival estimate of each tag group. Similar release and migration timing is important for comparing relative detection of tag groups to Columbia River dams because tag groups are likely to encounter the same collection efficiencies at detection sites. This condition was only met for the two groups of large steelhead released in mid-April. For these two groups, the larges released from BS were detected at JD and BN dams at about half the rate of the larges released from MN. These results are consistent with observations that pond

drainage has recently become less effective for releasing fish. The BS facility should be assessed to determine whether remedial measures are needed.

Radio telemetry indicated that most juvenile hatchery steelhead implanted with transmitters migrated downstream away from BS. There was a wide variation of migration behavior with some residing in BS outlet and Umatilla River pools while a few migrated. The effects of intrinsic features including size, smoltification, attraction to BS, transport recovery, and tagging response and extrinsic features including flow, temperature, and environment on migration behavior was not determined in this study. Snorkeling indicated that fish staying at BS outlet tended to stay there. Jonasson et. al (1994-95) reported that the smallest steelhead from releases of acclimated hatchery fish in the Grand Ronde River remained in high densities around release sites throughout the following summer. However, it is unclear what proportion of the releases remained. More information concerning the intrinsic and extrinsic effects on migration and the total numbers remaining and is needed.

The 15% of fish implanted with transmitters that migrated to the Umatilla River mouth is consistent with low SAS for the smaller graded fish. Knapp et al. 2000 estimated from PIT tag data that total outmigration to TMFD for this group was 56.6%. The earlier release of larger steelhead from BS had similar outmigration of 58.5% (Knapp et al. 2000). Differences in the outmigration estimates may be related to the small sample, selective tagging size, effect of tagging on radio telemetry, fish or the accuracy of estimating outmigration using PIT tags.

By combining stationary and mobile tracking actual fish movement was better understood. Three stationary receivers increased reliability and insured detection throughout the river not covered by mobile receivers. The reliability of radio telemetry in this study depended on loss associated with tagging, battery life, and detection of receivers. Radio telemetry monitoring is limited by tag and receiver cost, effort, and fish size. We concluded that continued radio tracking of steelhead smolt migration would not be practical.

Increases in PIT-tagging and remote detection capabilities at TMFD should increase PIT tag detection and improve accuracy. To test release time at BS a PIT-tagged group of small grade fish will be released earlier at MN and BS along with large grade fish. Similar migration to TMFD for these groups would help determine if migration is disrupted by river conditions for the later BS release.

Snorkel surveys identified pools in the Umatilla River that were utilized by migrating hatchery steelhead. Fish distribution, rearing origin, and fish implanted with radio transmitters could easily be determined during snorkel surveys. Thus, snorkel surveys would be an alternative when electroshocking and radio telemetry are not practical.

Adult Survival Studies

The master plan goals projected a SAS of 2.7% for steelhead reared in MI raceways at Umatilla Hatchery (ODFW and CTUIR 1990). This survival rate would produce 4,050 adults given current releases of 150,000 smolts. Survival of the 1991-94 broods has been well below this projection. Smolt-to-adult survival was only 0.08% for the first brood (1991) reared at high density and released in a drought year. The following three broods averaged 0.52% SAS. Two-thirds of the production (early-released larges) has performed better than indicated by this average. Survival of large steelhead has averaged 0.71% (0.39-1.20%) compared with 0.13% (0.04-0.27%) for small steelhead.

Information to date suggests the pre-hatchery projection for 2.7% SAS was too high. Although SAS comparisons of Umatilla steelhead with steelhead releases from other hatcheries is problematic, some information is noteworthy. Umatilla steelhead only achieve similar SAS as steelhead released in the Wallowa River which have to pass five additional mainstem dams. Also, SAS has been considerably higher for summer steelhead released in the nearby Walla Walla River (1.3-3.0%, Schuck et al. 1995, 1997, 1998) and Hood River (1.0-2.0%, R. French, ODFW, personal communication). However, several uncertainties still remain. It is unknown whether the lower than projected performance of steelhead was an outcome of erroneous assumptions in the model used to predict survival, poorer than anticipated environmental conditions, or rearing in Michigan raceways. A few more years of data are needed to better define what a "normal" range of SAS rates are for Umatilla River steelhead. Whether steelhead reared in OR raceways could outperform MI-reared steelhead will remain unanswered unless side-by-side tests of these two rearing systems are conducted.

Adult Returns to the Umatilla River

Supplementation goals for UFH were to build up the natural steelhead returns to 4,000 fish in five years. This was an optimistic time line that assumed the first returns of hatchery adults would be a large run that spawned successfully, freshwater habitat was available for the increased numbers of juvenile steelhead, offspring of hatchery adults would survive in freshwater and marine environments as well as natural offspring, and the freshwater and marine environments would remain favorable for high survival. We are past the five-year mark and there is no definitive evidence that natural steelhead production has increased. However, natural steelhead runs in the Umatilla River have been relatively stable this past decade while populations in some nearby basins have declined. The lack of a significant increase in natural production could be due to not meeting any of the above assumptions. We know numbers of adult hatchery fish returning to spawn have been lower than expected, particularly for the 1991 brood. However, we do not know at this time whether any of the other assumptions have been met. Monitoring efforts are currently underway that will provide information needed to answer some of these uncertainties. Natural production (Contor et al. 1995, 1996, 1997), outmigration (Knapp et al. 1996, 1998a, 2000), and hatchery (Keefe et al. 1993, 1994; Hayes et al. 1994, 1995, 1997, and 1999; Focher et al. 1998) monitoring are providing information on habitat availability, smolt production, outmigration success, adult production, and life history.

The Umatilla Hatchery steelhead program has increased the numbers of potential spawners even though these increases have been well below master plan projections. An average of five hatchery adults have returned to the Umatilla River and escaped fisheries for each fish spawned from brood years 1991-94. Since approximately 100 fish are removed from the run for broodstock each year, the net effect of the hatchery program has been an average addition of 393 potential spawners per year. This is far below an estimated 3,600 adult escapement that might occur if we were to achieve our 2.7% SAS goal. This high a level of hatchery escapement relative to natural escapement may no longer be acceptable now that mid-Columbia River steelhead are listed as threatened. Managers will likely begin the process of re-examining SAS and supplementation goals.

Fewer non-endemic hatchery steelhead passed TMFD this year compared with the previous five years. Lower numbers may have been associated with the relatively fast pace that the composite steelhead runs in the Columbia River moved past the Umatilla River. Largest numbers of non-endemic steelhead have been sampled these past two years in October and November which coincides with the time when high numbers of steelhead in the Columbia River are moving past the Umatilla River. Non-

endemic steelhead sampled at TMFD in the fall originate mostly from releases in the Tucannon River, and spring entrants are predominantly from releases in the Wallowa River. It is unknown what proportion of non-endemic steelhead will stay and eventually spawn. Spring entrants are probably more likely to move upriver and spawn than the fall entrants. Evaluating this question with radio telemetry would currently be impractical due to the difficulty in identifying non-endemic fish at TMFD. More snouts collected during the spring steelhead season in the upper river is needed. To date, one of ten snout were from non-endemic fish which is close to the proportions observed at TMFD.

Fishery

The UFH program has been successful at providing a steelhead fishery on the Umatilla River. Angling effort has exceeded 4,500 h since creel surveys were initiated in 1992. Regulation changes implemented in fall 1994 that opened the season three months earlier and extended it one month later expanded angler participation considerably. Opening the season earlier created a popular fishery below TMFD. Angler interviews almost doubled from 550 to 1,000 following the new regulations. Angling effort this year was the highest on record due to a significant increase in the upriver fishery. Participation in the upriver fishery this year was about twice as high as any previous season surveyed. This increase was probably a result of recent population growth in Umatilla County, and relatively mild weather and stable river flow this winter and spring. The Umatilla River steelhead fishery is comparable to those in the nearby Walla-Walla and Touchet rivers in terms of harvest and catch rate (Schuck et al. 1995, 1997) but much smaller than the Grande Ronde basin fishery (Flesher et al. 1996). Estimated hours fished and harvest in the Grande Ronde fishery is typically about five times greater than in the Umatilla River.

The upper Umatilla River fishery is predominantly catch-and-release of natural steelhead. Low catch rate of hatchery steelhead makes this fishery less appealing to harvest-oriented anglers. Anglers in the Pendleton area often travel elsewhere to seek better harvest opportunities. In spring, angling effort in the upper river can quickly drop and shift to the Grande Ronde basin when reports of "good fishing" are circulated. Current release sites for juvenile steelhead 10-30 miles upriver of the fishery are less then optimal for harvest. Catch patterns and radio-telemetry studies (Contor et al. 1997) suggest the upriver fishing area is primarily a migration corridor for hatchery steelhead rather than a holding area. Shifting juvenile release sites to an area within the fishery would likely improve harvest. However, present locations were selected as a balance between harvest, supplementation, and natural steelhead conservation goals.

Our creel survey likely underestimated steelhead catch and harvest on the Umatilla River and should be viewed as an index for documenting long term trends. Harvest estimated from punch-card data has been two to five times higher than our creel estimates. Actual harvest is probably somewhere between the two estimates. Underestimation of harvest from creel survey data may indicate significant fishing activity in areas of the river that are not surveyed. Creel surveys are presently restricted to areas of the river that have easy public access, receive high angling pressure, and can be effectively surveyed. Although periodic checks in the unsurveyed area from TMFD to Barnhart Bluffs have consistently documented light fishing pressure, accurate pressure counts are difficult due to poor access. There are some indications harvest in this area may be disproportionately high. Radio telemetry studies indicate steelhead spend roughly three times longer in the unsurveyed river from TMFD to Stanfield Dam than in the area above Stanfield Dam which is mostly surveyed (Contor et al. 1997). Several reports of exceptionally successful drift boat trips through the unsurveyed area have been reported to local ODFW district and research personnel. Reconnaissance aerial surveys at key times should be considered to more accurately estimate the amount and distribution of angling effort in the unsurveyed river. This information may be useful for developing methods to monitor angling effort and catch rates in this area.

Table 36. Egg-take and survival of summer steelhead reared at Umatilla Hatchery, brood years 1991-98.

Egg source	Brood year	Number of eggs taken or received	Egg-to-fry[a] survival (%)	Egg-to-smolt[b] survival (%)
Umatilla River	1991	410,356	65.1	56.8
Umatilla River	1992	476,871	81.5	66.6
Umatilla River	1993	255,441	85.8	85.4
Umatilla River	1994	234,432	85.1	81.9
Umatilla River	1995	223,525	86.8	75.4
Umatilla River	1996	215,408	81.6	69.9
Umatilla River	1997	209,639	82.4	76.0
Umatilla River	1998	228,622	63.2	57.6

[a] *Survival estimate adjusted for tranfer to Salmon and Trout Enhancement Program and destroying of surplus.*

[b] *Survival estimate is based on coded-wire tag reports and adjusted for grade-outs.*

Table 37. Feed conversion rates (lb fed/lb fish growth) for summer steelhead reared in Michigan raceways at Umatilla Hatchery (Umatilla stock) and Oregon raceways at Irrigon Hatchery (Imnaha and Wallwa stocks), brood years 1991-98.

Brood year	Umatilla Hatchery - Michigan raceways				Irrigon Hatchery – Oregon raceways		
	A-pass	B-pass	C-pass	Mean	Imnaha stock	Wallowa stock	Mean
91	1.59	1.75	1.87	1.74			1.10
92	1.55	1.43	1.53	1.49			1.18
93	1.35	1.18	1.12	1.22			0.90
94	0.92	0.93	0.99	0.93	1.10	0.95	1.03
95	1.07	0.98	0.94	1.00			
96	1.02	0.86	1.02	0.97	1.12	1.09	
97	0.92	0.78	0.87	0.86			
98	1.96	1.18	1.24	1.46	1.17		

Table 38. Rearing conditions immediately before transfer for summer steelhead in Michigan raceways at Umatilla Hatchery (Umatilla stock) and Oregon raceways at Irrigon Hatchery (Imnaha and Wallwa stocks), brood years 1991-98.

Brood Year	System	Maximum density (lb/ft^3)	Maximum loading (lb/gal/min)	Total number reared per gpm in Michigan system
1991	Michigan	5.4-6.7	11.8-14.6	210
1991	Oregon	1.3	6.6	
1992	Michigan	4.0-4.5	8.9-9.9	167
1992	Oregon	1.3	6.6	
1993	Michigan	3.8-4.6	8.4-10.1	161
1993	Oregon	1.4-1.5	6.7-7.4	
1994	Michigan	4.0-4.2	9.7-10.2	154
1994	Oregon	1.3-1.4	7.3-10.4	
1995	Michigan	4.1-4.3	9.8-10.4	154
1995	Oregon	1.2-1.4	5.9-6.9	
1996	Michigan	3.4-3.9	8.1-9.3	145
1996	Oregon	1.3-1.5	7.1-8.0	
1997	Michigan	3.7-3.8	8.7-9.1	145
1997	Oregon	1.3-1.5	7.1-8.0	
1998	Michigan	2.1-3.5	5.1-8.2	128
1998	Oregon	0.7-1.4	4.5-7.4	

Table 39. Water quality measurements in Michigan raceways that reared summer steelhead from 1992-98 at Umatilla Fish Hatchery. Means with different letters indicate significant differences ($P < 0.05$). First letters indicate difference among passes and second letters indicate difference between inlet and outlet within passes.

		Inlet			Outlet		
Parameter	Pass	N	Means	Min-Max	N	Means	Min-Max
Temperature	A	113	12.4 a x	10.4-15.2	113	12.4 a x	10.4-15.1
(°C)	B	93	12.5 a x	10.6-15.0	93	12.5 a x	10.6-15.0
	C	87	12.5 a x	10.2-14.9	86	12.5 a x	10.3-15.2
pH	A	108	7.78 a x	6.83-8.63	108	7.68 a y	6.79-8.30
	B	88	7.71ab x	7.08-8.30	88	7.63ab y	6.73-8.18
	C	82	7.64 b x	6.85-8.24	81	7.60 b x	6.73-8.14
Oxygen	A	110	12.1 a x	8.7-17.9	110	9.13 a y	5.7-11.9
(mg/L)	B	90	12.7ab x	8.7-19.5	90	9.51ab y	6.2-12.9
	C	82	13.0 b x	9.3-17.6	81	9.79 b y	7.2-14.5
Unionized	A				88	0.56 a	0.03-2.56
Ammonia	B				70	1.12 b	0.12-7.48
(µg/l)	C				65	1.49 c	0.23-11.75

Table 40. Mean length, weight, and condition factor for steelhead reared in Michigan and Oregon raceways at Umatilla Hatchery in 1998-99, 1998 brood.

		Length(mm)		Weight(g)		Condition factor	
Sample	Pass	N	Mean(SE)	N	Mean(SE)	N	Mean(SE)
				Oregon			
August:	A	97	52.0(0.4)	60	1.5(0.1)	60	1.16(0.01)
September:	A	105	69.6(0.8)	65	4.2(0.2)	65	1.19(0.01)
				Michigan			
October:	B	102	97.2(1.3)	54	12.6(0.8)	54	1.22(0.01)
November:	A	109	94.2(0.9)	54	10.3(0.4)	54	1.21(0.01)
	B	104	117.7(1.3)	47	19.7(1.0)	47	1.20(0.01)
	C	112	117.7(1.3)	57	22.7(2.0)	57	1.35(0.12)
December:	A	112	116.9(1.2)	51	18.6(0.9)	51	1.11(0.01)
	B	99	147.0(1.7)	59	36.5(1.7)	59	1.16(0.01)
	C	111	144.1(1.5)	48	37.1(1.9)	48	1.17(0.01)
January:	A	103	141.8(2.0)	50	36.3(2.5)	50	1.14(0.01)
	B	103	170.3(1.8)	56	58.7(2.7)	59	1.16(0.01)
	C	100	171.6(1.6)	55	60.4(2.2)	48	1.16(0.01)
February:	A	106	150.9(1.9)	49	38.5(2.2)	49	1.14(0.01)
	B	107	184.9(1.8)	51	68.1(2.8)	51	1.07(0.01)
	C	103	184.7(1.9)	61	70.2(2.7)	61	1.07(0.01)
March:	A	118	173.2(2.3)	59	64.0(3.9)	59	1.18(0.01)
Release[a]:	A	323	194.7(1.1)	100	76.4(2.6)	100	0.98(0.01)
	B	347	207.3(1.1)	102	91.9(2.9)	102	1.04(0.01)
	C	316	207.7(1.1)	105	83.2(2.5)	105	0.96(0.01)

[a] *Steelhead in A and C pass were acclimated and released at Bonifer Springs, steelhead in B pass were acclimated and released at Minthorn Springs.*

Table 41. Mean length, weight, and condition factor at release for summer steelhead reared in first, second, and third pass Michigan raceways at Umatilla Hatchery, 1991-98 broods (standard error in parentheses).

Brood year	Pass	Length (mm)	Weight (g)	Condition factor
1991	A	194.3(1.4)	91.0(3.2)	1.13(0.01)
	B	200.0(1.1)	90.2(2.4)	1.09(0.01)
	C	186.9(1.0)	76.7(2.1)	1.12(0.01)
1992	A	199.6(1.1)	74.8(2.1)	0.93(0.01)
`	B	198.2(1.2)	80.9(2.7)	1.01(0.01)
	C	220.1(1.0)	102.4(2.5)	0.93(0.01)
1993	A	205.9(1.2)	86.7(2.5)	0.97(0.01)
	B	198.3(1.2)	88.7(2.4)	1.05(0.01)
	C	214.2(1.1)	93.3(2.3)	0.94(0.01)
1994	A	206.3(1.1)	82.6(2.2)	0.90(0.01)
	B	209.7(1.0)	96.2(2.7)	1.00(0.01)
	C	205.9(0.8)	81.4(1.8)	0.90(0.01)
1995	A	207.9(1.1)	87.3(2.4)	0.99(0.01)
	B	206.8(1.3)	89.9(2.9)	0.98(0.01)
	C[a]	196.5(1.7)	85.4(3.2)	1.11(0.01)
1996	A	208.3(1.0)	93.3(2.3)	1.00(0.01)
	B	208.1(0.9)	99.5(1.5)	1.08(0.00)
	C	203.5(1.1)	84.8(1.7)	0.95(0.00)
1997	A	187.0(1.7)	71.9(2.9)	1.04(0.01)
	B	209.3(1.7)	95.5(3.1)	1.01(0.01)
	C[b]	202.3(1.3)	77.0(1.7)	0.94(0.00)
1998	A[b]	194.7(1.1)	76.4(2.6)	0.98(0.01)
	B	207.3(1.1)	91.9(2.9)	1.04(0.01)
	C[b]	207.7(1.1)	83.2(2.5)	0.96(0.01)

[a] *The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling. Measurements reported are from fish sampled at Umatilla Hatchery, approximately two weeks prior to transfer to acclimation ponds.*

[b] *Volitional release began one week prior to sampling fish on the day of forced release*

Table 42. Mean proportion of descaled, partially descaled, and undamaged steelhead reared in Michigan passes at Umatilla Hatchery, brood years 1991-98.

Brood year	Pass	Descaled[a]	Partially descaled[b]	Undamaged[c]
1991[d]	A	0.01	0.43	0.56
	B	0.05	0.39	0.61
	C			
1992	A	0.08	0.30	0.62
	B	0.03	0.56	0.41
	C	0.02	0.58	0.40
1993	A	0.05	0.13	0.82
	B	0.01	0.50	0.49
	C	0.11	0.33	0.56
1994	A	0.13	0.39	0.48
	B	0.00	0.21	0.79
	C	0.09	0.42	0.50
1995[e]	A	0.03	0.70	0.28
	B	0.01	0.31	0.69
	C			
1996	A	0.12	0.48	0.41
	B	0.02	0.35	0.63
	C	0.32	0.57	0.11
1997	A	0.00	0.04	0.96
	B	0.04	0.32	0.64
	C	0.05	0.34	0.61
1998	A	0.03	0.12	0.85
	B	0.00	0.06	0.94
	C	0.01	0.15	0.84

[a] *More than 0.20 descaling on either side of the fish.*

[b] *Descaling = 0.03 to 0.20 on either side of the fish.*

[c] *Less than 0.03 descaling on either side of the fish.*

[d] *Data not available.*

[e] *The 1995 brood steelhead from pond M8C escaped from the acclimation pond prior to sampling.*

Table 43. Tag and mark information for steelhead reared at Umatilla Hatchery and released in the Umatilla River in 1999, 1998 brood (CWT = coded-wire tag).

Raceway and PTAGIS PIT-tag file	Release date[a]	CWT code	Number recognizably tagged and clipped[b]	Number PIT-tagged fish released	PIT-tags extruded after 48 h (%)	PIT-tag mortalities after 48 h (%)	Total number released
M8A (WAC99091.M8A)	5/4/1999	092527	19,088	288	2.7	0.0	35,564
M8B (WAC99064.M8B)	4/13/1999	092526	20,787	210	18.0	0.0	41,843
M8C (WAC99064.M8C)	4/12/1999	092525	20,450	198	21.1	0.0	44,226

[a] *M8B-fish were released from Minthorn acclimation facility over a two day period beginning on 13 April 1999. Volitional release of M8A- and M8C-fish began one week prior their forced release on 4 May 1999 and 12 April 1999, respectively.*
[b] *All fish received an adipose fin clip and CWT fish were also left-ventral fin-clipped.*

Table 44. Number and percent detected, median travel time and passage date at John Day and Bonneville dams for PIT-tagged steelhead released in the Umatilla River, spring 1999.

		John Day			Bonneville		
Raceway	CWT code	Percent detected (Number)	Median travel time (d)	Median passage date	Percent detected (Number)[a]	Median travel time (d)	Median passage date
M8A	092527	5.6(16)	31	6/4/1999	2.1(6)	27	5/31/1999
M8B	092526	14.8(31)	41	5/24/1999	8.1(17)	43	5/26/1999
M8C[b]	092525	6.6(13)	38	5/20/1999	4.0(8)	44	5/26/1999

[a] *Percent and number detected at Bonneville Dam includes the following numbers of PIT-tagged fish previously detected at John Day Dam: 1-M8A, 8-M8B, 4-M8C.*
[b] *Travel time was based on forced release date*

Table 45. Recovery data for branded, paint-marked, and PIT-tagged steelhead reared in A, B, and C pass Michigan raceways at Umatilla Hatchery, released in the Umatilla River, and recaptured or detected at John Day Dam, brood years 1992-98 (number of observed recoveries in parentheses).

Migration Year	Mark	Estimated percent passage[a]		
		M8A	M8B	M8C
1993	Brand	3.3 (20)	28.7 (191)	19.4 (119)
1994	Brand	8.9 (53)	8.4 (51)	3.7 (22)
1995	Brand	2.0 (6)	3.0 (4)	2.0 (3)
1996	Brand	0.0 (0)	0.0 (0)	0.8 (1)
1997	Paint	1.0 (3)	[b]	[b]
		Percent detected[c]		
1998	PIT-tag	8.7 (21)	18.0 (44)	17.6 (44)
1999	PIT-tag	5.6 (16)	14.8 (31)	6.6 (13)

[a] *Brand recoveries from 1993-1997 were expanded by sampling and collection efficiency to estimate percent passage.*
[b] *Fish from M8B or M8C were not marked with paint.*
[c] *PIT tag detections in 1998 and 1999 are not expanded for bypass collection efficiency. PIT tag detection (sampling) efficiency was 100% in 1998 and 1999.*

Table 46. Mean fork length at tagging of PIT-tagged steelhead released in the Umatilla River and detected at John Day and Bonneville dams, spring 1999. Means with different letters indicate significant differences ($P < 0.05$).

Raceway	Length (mm) at tagging		Length at tagging of detected fish	
	Number	Mean(SE)	Number	Mean(SE)
M8A	281	177.0(1.4) A	21	188.8(3.1) B
M8B	256	190.9(1.1) A	40	196.2(2.4) B
M8C	251	191.9(1.3) A	24	211.8(5.7) B

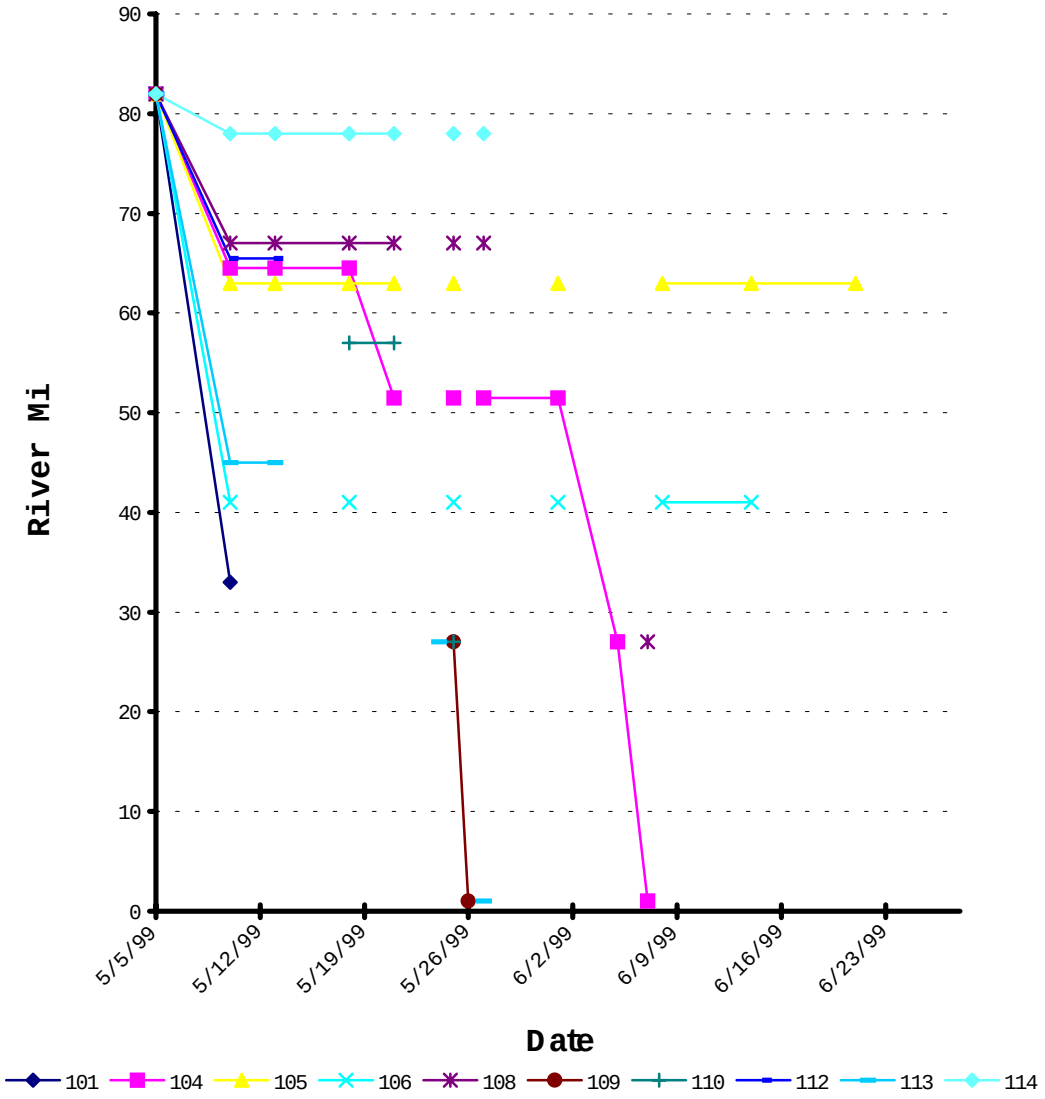

Figure 4: Detection of radio-tagged small-grade steelhead after release into the Umatilla River May 4, 1999.

Table 47. Snorkeling number and density of hatchery summer steelhead at four sites on the Umatilla River.

	Date					
	6/21/1999		7/21/1999		8/20/1999	
Site	Number	Density[a]	Number	Density	Number	Density
Bonifer Spring Outlet (RM2)	55	0.57	42	0.44	41	0.43
Meacham Creek screw trap site (RM 1)	10	0.05	10	0.05	16	0.09
Meacham Creek-Umatilla River confluence (RM 79)	20	0.06	3	0.01	0	0.00
Umatilla River screw trap site (RM 80)	1	<0.01	2	<0.01	0	0.00

[a] *Density equals fish/m^2.*

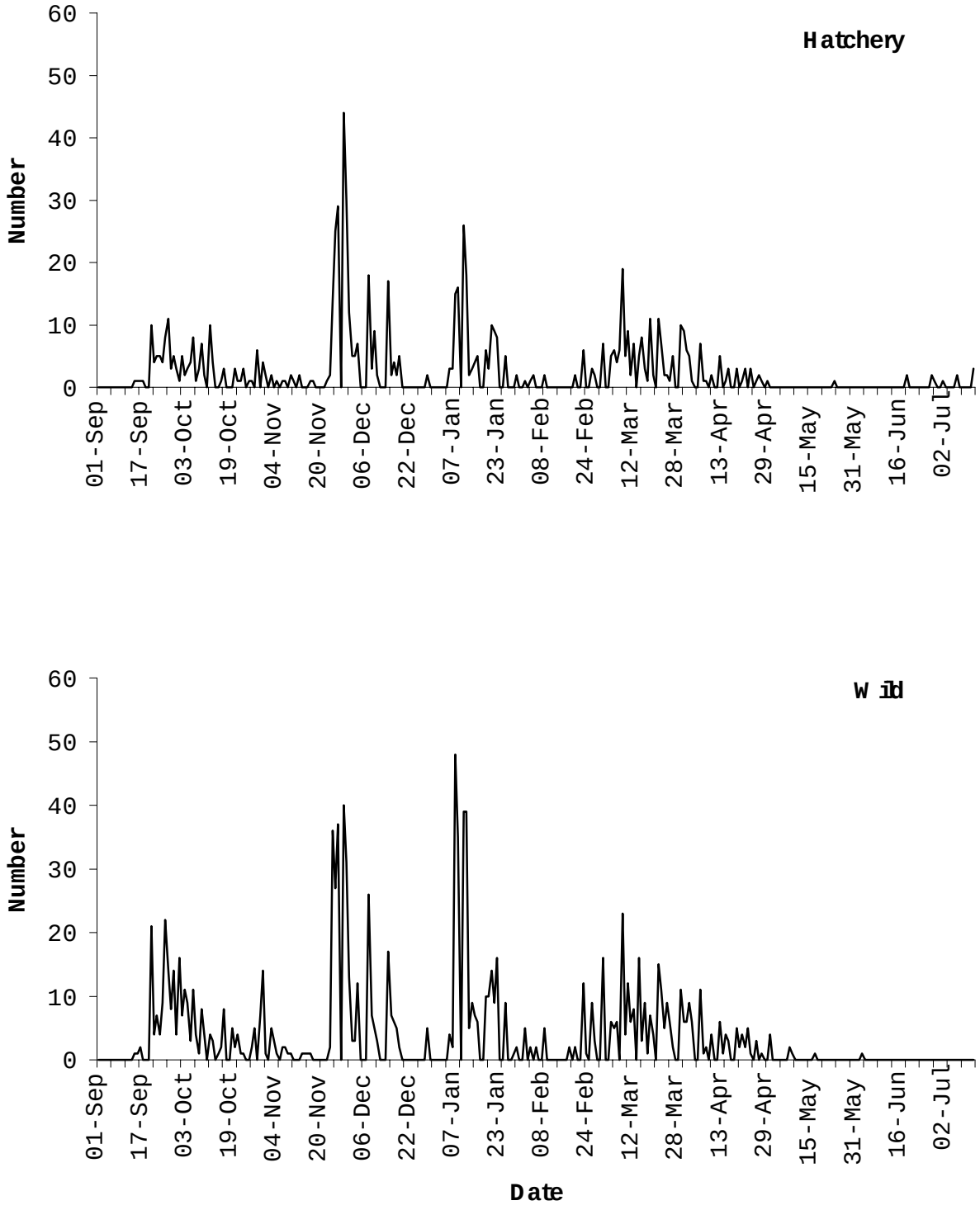

Figure 5. Numbers of wild and hatchery steelhead counted at the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1998-99.

Table 48. Exploitation and survival of steelhead reared at Umatilla Hatchery, coded-wire-tagged (CWT) and released in the Umatilla River, 1991-96 broods. Recoveries are incomplete for all brood years. Estimates of number of adults recovered are based on total production in each raceway. Data was downloaded in January 1999.

Brood year, CWT code	Raceway	N[a]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number of adults recovered
1991						
075838	M5A	1	0.0	0.01	0.01	2
075839	M5A	1	0.0	0.01	0.01	2
075840	M5A	1	0.0	0.01	0.01	2
075841	M5B	2	100.0	0.00	0.02	4
075842	M5B	0	0.0	0.00	0.00	0
075843	M5B	4	100.0	0.00	0.04	9
074127	M5C	27	0.0	0.26	0.26	58
073862	M5C	14	42.9	0.08	0.13	30
073759	M5C	23	52.2	0.11	0.22	50
Total/Average		73	32.9	0.05	0.08	141
1992						
076052	M5A	8	0.0	0.06	0.06	13
076053	M5A	11	0.0	0.10	0.10	21
076054	M5A	8	0.0	0.08	0.08	18
076055	M5B	70	4.3	0.67	0.70	112
076056	M5B	56	1.8	0.58	0.60	95
076057	M5B	59	11.9	0.54	0.61	98
076058	M5C	70	18.6	0.56	0.69	103
076059	M5C	42	9.5	0.39	0.43	64
076060	M5C	74	18.9	0.64	0.78	117
Total/Average		398	7.2	0.37	0.43	621
1993						
070139	M5A	5	20.0	0.05	0.06	15
070140	M5A	1	0.0	0.01	0.01	3
070141	M5B	32	15.6	0.27	0.32	79
070142	M5B	62	45.2	0.34	0.62	155
070143	M5C	66	22.7	0.28	0.63	167
070144	M5C	63	11.1	0.58	0.65	163
Total/Average		229	19.1	0.26	0.38	582

[a] *Expanded CWT recoveries*

Table 48. (continued)

Brood year, CWT code	Raceway	N[a]	Total exploi-tation rate (%)	Umatilla return rate (% of release)	Total survival rate (% of release)	Number adults recovered
1994						
070655	M5A	54	3.7	0.17	0.27	131
070656	M5B	129	20.2	0.55	0.69	343
070657	M5C	231	13.4	1.04	1.20	581
Total/Average		414	16.8	0.62	0.72	1055
1995						
071034	M8A	28	0.0	0.14	0.14	68
071035	M8B	134	3.0	0.66	0.68	323
071036	M8C	64	9.4	0.30	0.30	149
Total/Average		226	4.1	0.37	0.37	539
1996						
091837	M8A	3	0.0	0.02	0.02	7
091836	M8B	95	0.0	0.50	0.50	233
091835	M8C	48	0.0	0.25	0.25	102
Total/Average		146	0.0	0.37	0.37	335

Table 49. Parent-progeny and parent-fishery escapement ratios for summer steelhead reared in Michigan raceways at Umatilla Hatchery, brood years 1991-1995.

Brood year	Race-way	Size (fish/lb)	Release location	Release date	No. parents spawned	Adult progeny produced	Fishery[a] escapement	Parent-progeny ratio	Parent-escapement[a] ratio
91	M5A	5.5	Meacham Ck	050192	43	6	0	0.1	0.0
91	M5B	5.0	Meacham Ck	043092	41	13	13	0.3	0.3
91	M5C	5.8	Bon./Min.	032992	43	138	95	3.2	2.2
92	M5A	6.1	Bonifer	051393	36	52	38	1.4	1.0
92	M5B	5.6	Minthorn	041693	27	305	253	11.4	8.8
92	M5C	4.5	Bonifer	041893	25	284	217	11.4	8.1
93	M5A	5.2	Bonifer	051294	33	18	16	0.5	0.5
93	M5B	4.9	Minthorn	041494	33	234	195	7.1	5.9
93	M5C	5.1	Bonifer	041194	32	330	276	10.4	8.7
94	M8A	5.5	Bonifer	051295	31	131	113	4.2	3.6
94	M8B	4.7	Minthorn	041395	33	343	249	10.5	7.6
94	M8C	5.6	Bonifer	041195	32	581	505	18.3	15.9
95	M8A	5.1	Thornhollow	050996	27	68	58	2.5	2.1
95	M8B	5.1	Minthorn	041296	26	323	264	12.3	10.2
95	M8C	5.3	Bonifer	042496	27	149	128	5.5	4.7

[a] *Escapement from tribal and non-tribal fisheries in the Umatilla River.*

Table 50. Number of steelhead that returned to the east-bank fish ladder, Three Mile Falls Dam, Umatilla River, 1998-99 run year.

	Male		Female		Unknown		Total	
Origin[a]	Number	%	Number	%	Number	%	Number	%
Hatchery	273	43.1	478	38.2	0	0.0	751	39.8
Natural	361	56.9	774	61.8	0	0.0	1,135	60.2
Total	634	33.6	1,252	66.4	0	0.0	1,886	100.0

[a] *Origin determined by presence or absence of adipose fish.*

Table 51. Vital statistics of natural (unmarked) and hatchery steelhead that returned to the east-bank fish ladder at Three Mile Falls Dam, Umatilla River, 1998-99. Data for hatchery fish was determined from coded-wire tag recovery of Umatilla origin fish. Age of wild fish was determined from scale analysis (P. Kissner, CTUIR, personal communication). Sex was determined visually.

				Fork length (mm)		
Brood year	Age	Number	Sex	mean	min	max
			Natural			
1993	3.2	1	male		795	
1994	2.2	9	male	747	685	805
	2.2	15	female	696	650	750
1995	1.2	1	male		769	
	1.2	4	female	701	600	763
	2.1	13	male	603	560	685
	2.1	9	female	607	563	675
1996	1.1	3	male	575	565	595
			Hatchery			
1995	1.2	9	male	722	622	790
1995	1.2	25	female	721	660	770
1996	1.1	22	male	622	570	680
1996	1.1	24	female	616	570	652

Table 52. Percent of hatchery and natural steelhead run to Three Mile Falls Dam that were males or spent one year in saltwater (one-salt), run years 1992-93 to 1998-99.

	Males (%)		One-salt (%)	
Run year	hatchery	natural	hatchery	natural
1992-93	41.8	29.9	56.8	50.7
1993-94	26.4	27.1	31.6	62.3
1994-95	47.8	26.3	80.5	37.0
1995-96	43.1	28.9	78.2	67.0
1996-97	50.8	26.8	74.3	54.8
1997-98	41.3	31.2	51.9	69.7
1998-99	43.1	31.8	60.2	58.8
mean	42.0	28.9	61.9	57.2

Table 53. Origin and number of endemic and non-endemic hatchery steelhead in the Umatilla River, run years 1992-93 through 1998-99. Data shown are number of coded-wire-tags observed (Obs), estimated number of hatchery steelhead (Est'd), percent of the hatchery steelhead run (% HSTS), and percent of entire steelhead run (% All STS).

Run Year	Umatilla Rr	Tucannon Rr	Wallowa Rr (Spring Creek)	Wallowa Rr (Deer Creek)	Salmon Rr	Touchet Rr	Clearwater Rr	Imnaha Rr	Walla Walla Rr	Columbia Rr	All Non-endemic
1992-93											
(Obs)	(137)	(0)	(4)	(0)	(6)	(2)	(1)	(2)	(0)	(0)	(12)
Est'd	486	0	21	0	26	29	34	19	0	0	128
(% HSTS)	(78.9)	(0.0)	(3.4)	(0.0)	(4.2)	(4.7)	(5.5)	(3.0)	(0.0)	(0.0)	(20.8)
% All STS	25.4	0.0	1.1	0.0	1.3	1.5	1.8	1.0	0.0	0.0	6.7
1993-94											
(Obs)	(92)	(1)	(0)	(0)	(0)	(1)	(1)	(0)	(0)	(0)	(3)
Est'd	326	3	0	0	0	6	10	0	0	0	19
(% HSTS)	(94.5)	(0.8)	(0.0)	(0.0)	(0.0)	(1.8)	(2.9)	(0.0)	(0.0)	(0.0)	(5.5)
% All STS	25.3	0.2	0.0	0.0	0.0	0.5	0.8	0.0	0.0	0.0	1.5
1994-95											
(Obs)	(79)	(10)	(0)	(1)	(1)	(1)	(0)	(0)	(1)	(0)	(14)
Est'd	510	77	0	4	42	22	0	0	2	0	147
(% HSTS)	(77.6)	(11.7)	(0.0)	(0.6)	(6.4)	(3.3)	(0.0)	(0.0)	(0.4)	(0.0)	(22.3)
% All STS	33.3	5.0	0.0	0.3	2.7	1.4	0.0	0.0	0.2	0.0	9.6
1995-96											
(Obs)	(77)	(9)	(1)	(0)	(0)	(0)	(0)	(1)	(3)	(1)	(15)
Est'd	661	52	37	0	0	0	0	4	28	4	125
(% HSTS)	(84.2)	(6.6)	(4.7)	(0.0)	(0.0)	(0.0)	(0.0)	(0.5)	(3.6)	(0.5)	(15.9)
% All STS	31.8	2.5	1.8	0.0	0.0	0.0	0.0	0.2	1.3	0.2	6.0
1996-97											
(Obs)	(80)	(11)	(1)	(1)	(0)	(0)	(0)	(1)	(0)	(0)	(14)
Est'd	1225	169	53	6	0	0	0	24	0	0	253
(% HSTS)	(82.9)	(11.4)	(3.6)	(0.4)	(0.0)	(0.0)	(0.0)	(1.6)	(0.0)	(0.0)	(17.1)
% All STS	49.5	6.8	2.2	0.2	0.0	0.0	0.0	1.0	0.0	0.0	10.2
1997-98											
(Obs)	(70)	(13)	(3)	(0)	(1)	(0)	(1)	(0)	(0)	(0)	(18)
Est'd	699	107	89	0	4	0	4	0	0	0	204
(% HSTS)	(77.4)	(11.8)	(9.9)	(0.0)	(0.5)	(0.0)	(0.4)	(0.0)	(0.0)	(0.0)	(22.6)
% All STS	39.6	6.1	5.1	0.0	0.2	0.0	0.2	0.0	0.0	0.0	11.6

Table 53 (continued)

Run Year	Umatilla Rr	Tucannon Rr	Wallowa Rr (Spring Creek)	Wallowa Rr (Deer Creek)	Salmon Rr	Touchet Rr	Clearwater Rr	Imnaha Rr	Walla Walla Rr	Columbia Rr	All non-endemic
1998-99											
(Obs)	(87)	(2)	(1)	(1)	(0)	(0)	(0)	(0)	(0)	(0)	(4)
Est'd	684	29	31	7	0	0	0	0	0	0	67
(% HSTS)	(91.1)	(3.8)	(4.2)	(0.9)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(0.0)	(8.9)
% All STS	25.0	1.5	1.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	3.6
Mean Est'd	657	62	33	2	10	8	7	7	4	0.6	134
Mean % All	35.3	3.4	1.8	0.1	0.6	0.4	0.4	0.4	0.2	0.03	7.1

Table 54. Estimated catch statistics for steelhead in the Umatilla River in 1998-99. Lower river = mouth of the Umatilla River to Three Mile Falls Dam. Upper River = Barnhart Bluffs to the lower boundary of the Confederated Tribes of the Umatilla Indian Reservation. Number caught and number harvested includes ± 95% confidence interval.

Month, Day type	Number sampled days	Number sampled anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
			Lower River			
September						
Weekday	9	14	97	11±14	6± 9	0.11
Weekend	7	25	113	7±14	0± 0	0.06
Total	16	39	210	18±20	6± 9	0.08
October						
Weekday	10	125	984	32+23	14±16	0.03
Weekend	9	194	869	52±30	21±16	0.06
Total	19	319	1853	84±38	35±23	0.05
November						
Weekday	6	44	535	20±23	0± 0	0.04
Weekend	9	147	701	27±18	13±11	0.04
Total	15	191	1236	47±29	13±11	0.04
Lower river						
Total	50	549	3299	149± 52	54±27	0.05

Table 54 (continued).

Month / Day type	Number sampled: days	Number sampled: anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
			Upper River			
January						
Weekday	6	79	983	56±49	15±20	0.06
Weekend	5	108	1099	35±46	7±12	0.03
Total	11	187	2082	91±67	22±24	0.04
February						
Weekday	8	70	954	20±30	3± 6	0.02
Weekend	8	95	761	23± 9	4± 5	0.03
Total	16	165	1715	43±32	7± 8	0.03
March						
Weekday	4	50	746	66±71	6±12	0.09
Weekend	5	106	555	12± 8	2± 3	0.02
Total	9	156	1301	78±72	8±13	0.04
April						
Weekday	5	36	213	6± 9	6± 9	0.03
Weekend	4	58	195	15±30	4± 8	0.08
Total	9	94	408	21±31	10±12	0.06
Upper river total	45	792	5506	233±108	47±31	0.04
Grand Total	95	1341	8805	382±119	101±41	0.04

Table 55. Summary of steelhead catch statistics, 1992-99 run years. Data is combined from lower river (Umatilla mouth to Three Mile Falls Dam) and upper river (Barnhart Bluffs to lower boundary of the Confederated Tribes of the Umatilla Indian reservation).

Year[a]	Number anglers	Hours fished	Number caught	Number harvested	Catch rate (fish/h)
1992-93	543	5,293	177	37	0.040
1993-94	577	4,504	63	19	0.014
1994-95	1,070	6,172	257	61	0.042
1995-96	880	4,560	232	60	0.051
1996-97	1,356	5,931	294	90	0.048
1997-98	886	6,676	382	101	0.058
1998-99	1341	8,805	382	101	0.044

[a] *Angling season in 1992-93 and 1993-94 was from 1 December to 15 March. Beginning in 1994-95 the angling season was from 1 September to 15 April*

Table 56. Descriptive statistics for the steelhead fishery in the Umatilla River, run years 1993-94 through 1998-99. Catch statistics were based on creel surveys conducted in the lower river (Umatilla mouth to Three Mile Falls Dam) and upper river (Barnhart Bluffs to lower boundary of the CTUIR).

Statistic[a]	Fish origin[b] or creel area	Run year 93-94	94-95	95-96	96-97	97-98	98-99	Mean
Run size	NSTS	945	875	1296	1014	862	1135	1021
	HSTS	359	696	819	1529	994	805	867
Run composition (%)	NSTS	72	56	61	40	46	59	54
	HSTS	28	44	39	60	54	41	46
Catch composition (%)	NSTS	59	67	70	59	62	65	64
	HSTS	41	33	30	41	38	35	36
Number caught	NSTS	37	172	161	168	239	250	171
	HSTS	26	85	69	115	146	132	96
Composition of lower river catch (%)	NSTS	49	67	64	59	49	50	56
	HSTS	51	33	36	41	51	50	44
Composition of upper river catch (%)	NSTS	71	66	75	60	78	75	71
	HSTS	29	34	25	40	22	25	29
Location of NSTS catch (%)	Lower Rr.	46	70	44	71	44	30	51
	Upper Rr.	54	30	56	29	56	70	49
Location of HSTS catch (%)	Lower Rr.	69	68	56	72	74	56	66
	Upper Rr.	31	32	44	28	26	44	34
Percent of NSTS run caught	Lower Rr.	1.8	13.7	5.4	11.9	12.2	6.6	8.6
	Upper Rr.	2.1	5.9	7.0	4.7	15.5	15.4	8.4
Percent of HSTS run caught	Lower Rr.	5.0	8.3	4.7	5.4	10.9	10.0	7.4
	Upper Rr.	2.2	3.9	3.7	2.1	3.8	7.8	3.9
Percent of HSTS run harvested	Lower Rr.	3.9	5.7	4.2	4.3	9.2	7.3	5.8
	Upper Rr.	1.4	3.0	3.1	1.6	1.2	6.4	2.8

[a] *Hatchery steelhead run = number counted at Three Mile Falls Dam plus harvest below Three Mile Falls Dam; natural steelhead run = number counted at Three Mile Falls Dam.*

[b] *NSTS = wild steelhead; HSTS = hatchery steelhead; Lower Rr. = lower river creel area; Upper Rr. = upper river creel area.*

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Appendix Table A-1. Release information for salmon and steelhead reared at Umatilla, Bonneville, Little White Salmon, Carson, and Willard hatcheries and released into the Umatilla River in 1999 (Acclimation sites: BS=Bonifer Springs, IC = Imeques-c-mem-ini-kem,; MI=Minthorn acclimation site; TH = Thornhollow).

Race-species, release strategy, system	Brood year	Date released	Number released	Mean fork length (mm)	Mean weight (g)	Accli-mation (days)	Release location
Umatilla Hatchery							
Fall chinook salmon							
subyearlings	1998						
Michigan		5/3/1999	1,842,666	91.0	8.1	18-21	IC
Spring chinook salmon							
Yearlings	1997						
Oregon		12/20/1999	114,370	128.3	25.0	33	IC
Oregon		3/8/1999	104,722	141.6	33.6	41-42	IC
Michigan		3/8/1999	149,109	141.6	33.6	41-42	IC
			368,201				
Summer steelhead	1998						
Michigan		5/5/1999	35,564	194.7	76.4	19	BS
Michigan		4/14/1999	41,843	207.3	91.9	26	MI
Michigan		4/13/1999	44,226	207.7	83.2	28	BS
Total			121,633				
Bonneville Hatchery							
Fall chinook salmon							
Yearlings	1997						
Oregon		3/11/1999	233,861	161.2	48.2	21-23	TH
Oregon		4/15/1999	215,707	165.3	50.2	29-30	TH
Total			449,568				
Carson Hatchery							
Spring chinook salmon							
Yearlings	1997						
Oregon		4/14/1999	103,761	139.9	34.2	0	IC
Little White Salmon Hatchery							
Spring chinook salmon							
Yearlings	1997						
		3/8/1999	177,655	133.4	28.1	18	TH
		4/14/1999	124,360	145.2	35.8	36	TH
Total			302,015				

Appendix Table A-2. Release data for subyearling fall chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5; IC=Imeques-C-mem-ini-kem acclimation facility, RM 80).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
1991							
071433	5/18/1992	M2A	303,878	29,066	7,445	61.0	42.5
071434	5/18/1992	M3A	306,802	31,224	6,917	65.7	42.5
071435	5/18/1992	M2B	297,331	30,326	9,643	60.9	42.5
071436	5/18/1992	M3B	302,555	30,365	7,049	61.9	42.5
071437	5/18/1992	M2C	223,830	30,508	7,526	55.2	42.5
071438	5/18/1992	M3C	301,831	30,924	7,656	64.5	42.5
subtotal			1,736,227	182,413	46,236	61.8	
071430	5/19/1992	O2A	281,350	32,287	9,174	65.1	42.5
071429	5/20/1992	O3A	286,578	31,892	6,272	70.6	42.5
071432	5/19/1992	O2B	191,257	29,425	8,558	58.3	42.5
071431	5/19/1992	O3B	182,931	28,951	8,863	56.2	42.5
subtotal			942,116	122,555	32,867	63.7	
Total			2,680,343	304,968	79,103	62.5	
1992							
076330	5/24/1993	M2A	292,895	28,964	10,027	63.0	73.5
076331	5/24/1993	M3A	282,125	29,537	10,053	67.0	73.5
070127	5/24/1993	M2B	269,336	27,092	10,150	63.4	73.5
076333	5/24/1993	M3B	273,662	29,718	10,020	60.3	73.5
076334	5/24/1993	M2C	282,175	29,958	9,434	68.0	73.5
076332	5/24/1993	M3C	277,931	29,451	9,894	61.5	73.5
subtotal			1,678,124	174,720	59,578	63.9	
070126	5/25/1993	O2A	268,001	29,594	10,458	59.3	73.5
070125	5/25/1993	O3A	272,496	29,360	9,828	59.4	73.5
076329	5/25/1993	O2B	203,731	30,706	10,278	59.4	73.5
076335	5/25/1993	O3B	207,565	30,462	10,547	59.4	73.5
subtotal			951,793	120,122	41,173	59.4	
Total			2,629,917	294,842	101,361	62.3	
1993							
070663	5/23/1994	M2A	322,867	31,162	10,171	63.0	73.5
070719	5/23/1994	M3A	327,700	31,658	9,725	72.4	73.5
070720	5/23/1994	M2B	314,518	30,528	10,008	65.4	73.5
070723	5/23/1994	M3B	326,408	30,447	10,217	68.2	73.5
070722	5/23/1994	M2C	303,843	30,950	9,769	68.0	73.5
070721	5/23/1994	M3C	306,105	28,474	9,373	68.7	73.5
subtotal			1,901,441	183,219	59,263	67.6	

[a] *All coded-wire tagged fish were adipose fin-clipped. Fish from the 1991-97 broods were also RV-clipped. Beginning with the 1993 brood, all non coded-wire tagged fish were blank-wire tagged.*
[b] *Fish from 1991-95 broods were branded.*

Appendix Table A-2 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
1993							
070662	5/24/1994	O2A	280,046	31,239	10,158	60.1	73.5
070718	5/24/1994	O3A	279,965	31,040	10,220	64.2	73.5
070716	5/24/1994	O2B	191,321	30,502	10,906	59.1	73.5
070717	5/24/1994	O3B	190,439	32,481	10,260	60.0	73.5
subtotal			941,771	125,262	41,544	61.1	
Total			2,843,212	308,481	103,331	65.5	
1994							
071019	5/31/1995	M2A	286,459	29,353	10,665	62.7	IC
071017	5/31/1995	M3A	271,129	29,736	10,172	67.8	IC
071022	5/31/1995	M2B	280,406	28,472	10,323	63.0	IC
071020	5/31/1995	M3B	275,613	29,460	10,183	65.6	IC
071025	5/31/1995	M2C	274,110	29,784	10,176	66.5	TH
071023	5/31/1995	M3C	287,313	28,623	10,249	63.0	TH
subtotal			1,675,030	175,428	61,768	64.7	
071026	5/31/1995	O1A	245,885	30,106	10,374	58.0	IC
071018	5/31/1995	O3A	241,342	29,132	10,438	65.1	IC
071024	5/31/1995	O1B	151,943	30,204	10,248	62.3	IC
071021	5/31/1995	O3B	152,098	29,327	11,104	58.7	IC
subtotal			791,268	118,769	42,167	61.1	
Total			2,466,298	294,197	103,946	63.6	
1995							
071320	5/30/1996	M2A	303,803	30,015	10,557	69.5	IC
071321	5/30/1996	M3A	299,233	28,997	9,407	68.4	IC
071323	5/30/1996	M2B	300,377	29,914	9,965	62.8	IC
071325	5/30/1996	M3B	300,895	30,220	10,389	67.4	IC
071157	5/31/1996	M2C	393,339	29,852	10,316	72.8	TH
071327	5/31/1996	M3C	460,259	28,476	10,378	69.5	TH
	5/31/1996	M4C	251,582			66.3	TH
subtotal			2,309,488	177,474	61,012	68.4	
071322	5/30/1996	O2A	266,913	29,646	10,252	57.2	IC
071324	5/30/1996	O3A	272,594	30,243	10,420	66.4	IC
071326	5/30/1996	O2B	181,291	30,238	10,237	56.5	IC
071328	5/30/1996	O3B	181,709	30,455	9,980	60.3	IC
subtotal			902,507	120,582	40,889	60.5	
Total			3,211,995	298,056	101,901	66.2	

Appendix Table A-2 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT tag[c]	Fish per pound	Release location (RM)
1996							
092129	5/30/1997	M1A	294,417	33,161	8,469	63.6	IC/TH
092130	5/30/1997	M1B	294,043	32,464		62.4	IC/TH
092132	5/29/1997	M1C	304,993	31,382		66.8	IC
092131	5/30/1997	M2A	395,493	31,844	8,094	67.9	IC/TH
092133	5/29/1997	M2B	394,250	33,273		70.7	IC
092134	5/29/1997	M2C	311,016	33,640		67.6	IC
092126	5/30/1997	M4A	197,028	33,555	9,000	67.2	TH
092127	5/29/1997	M4B	195,031	32,764		70.2	IC
092128	5/29/1997	M4C	194,562	29,732		65.6	IC
Total			2,580,833	291,815	27,238	67.0	
1997							
092404	5/28/1998	M2A	214,521	33,286	520	65.2	TH
092407	6/1/1998	M2B	202,816	33,661	505	66.3	TH
092410	6/1/1998	M2C	215,643	31,820	508	66.7	IC
092403	5/28/1998	M3A	305,038	30,808	493	65.5	TH
092406	6/1/1998	M3B	317,296	30,558	510	67.3	IC
092409	6/1/1998	M3C	302,336	32,219	509	67.1	IC
092402	5/28/1998	M4A	400,614	30,654	504	64.1	TH
092405	5/28/1998	M4B	413,832	30,533	507	67.2	IC
092408	5/28/1998	M4C	405,346	32,322	508	69.8	IC
Total			2,777,442	284,861	4,564	66.7	
1998							
092701	6/3/1999	M2A	201,224	64,881	590	54.5	TH
092663	6/3/1999	M2B	203,951	66,220	592	54.7	TH
092703	6/3/1999	M3A	311,370	65,821	567	54.7	TH
092702	6/3/1999	M3B	305,731	63,127	589	56.7	IC
092705	6/3/1999	M4A	411,424	63,147	589	55.7	TH
092704	5/3/1999	M4B	408,424	63,757	591	57.5	IC
Total			1,842,666	386,953	3,518	55.9	

[c] *Fish from 1996 brood were paint marked on the anal fin, 1997-98 broods were PIT-tagged.*

Appendix Table A-3. Release data for yearling fall chinook salmon reared at Bonneville, Umatilla and Willard hatcheries and released in the Umatilla River (RM= river mile, TH=Thornhollow acclimation facility, RM 73.5, IC=Imeques acclimation facility).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
			Bonneville Hatchery				
1990							
075619	3/19/1992	A8	122,639	26,160		7.5	56.0
075618	3/17/1992	A9	97,801	26,178		7.5	70.0
Total			220,440	52,338		7.7	
1991							
071461	3/18/1993	A5	66,345	23,239		8.7	73.5
071460	3/18/1993	A6	68,492	23,863		9.1	73.5
Total			134,837	47,102		8.9	
1992							
070252	4/19/1994	A5	49,824	23,470		8.5	73.5
070255	3/23/1994	A6	233,629	23,699		10.4	73.5
Total			283,453	47,169		9.5	
1993							
070658	4/7/1995	A2	111,817	24,865		7.8	TH
070659	4/7/1995	A5	115,271	24,374		8.2	TH
Total			227,088	49,239		8.0	
1994							
071037	4/5/1996	A4	204,022	27,397	5,218	7.0	TH
071038	4/18/1996	A3	217,294	28,521	5,111	7.0	IC
Total			421,316	55,918	10,329	7.0	
1996							
092037	3/13/1998	A11	256,910	27,402	252	10.8	TH
1997							
092651	3/11/1999	A5	233,861	24,693	248	9.4	TH
092652	4/15/1999	A11	215,707	24,402	236	9.1	TH
Total			449,568	49,095	484	9.3	

[a] *All fish were RV fin-clipped and all coded-wire-tagged fish were adipose fin-clipped. Beginning with the 1992 brood, all non coded-wire-tagged fish were blank-wire-tagged.*
[b] *Fish from 1994 brood were branded, 1996 brood was PIT-tagged.*

Appendix Table A-3, (continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT tag[b]	Fish per pound	Release location (RM)
			Umatilla Hatchery				
1994							
071039	4/18/1996	M3A	48,499	23,238	5,197	5.3	IM
071040	4/18/1996	M3B	47,463	23,442	5,449	4.7	IM
071041	4/18/1996	M3C	47,125	23,343	5,313	5.3	IM
Total			143,087	70,023	15,959	5.1	
1995[b]							
091729	3/25/1997	O3A	53,993	25,250	4,180	7.6	IC/TH
091748	3/25/1997	O3B	51,917	25,260	4,798	7.6	IC
subtotal			105,910	50,510	4,180	7.6	
071358	3/25/1997	M1A	51,112	25,983		8.2	TH
091807	3/25/1997	M1B	51,066	25,258		8.2	TH
071359	3/25/1997	M1C	50,865	25,232		8.1	TH
subtotal			153,043	76,473	4,798	8.2	
Total			258,953	126,983	8,978	7.9	
			Willard Hatchery				
1995							
070953	3/30/1997	45	169,478	29,983		13.7	TH
070954	3/30/1997	46	91,490	30,344		13.4	TH
Total			260,968	60,327		13.6	
1996							
071158	4/17/1998	41	89,106	21,547	255	7.8	TH
076127	4/17/1998	42	89,994	22,783	258	7.8	TH
Total			179,100	44,330	513	7.8	

[b] *The 1994 brood was branded. The 1995 brood was paint-marked 4,180 fish were paint-marked red on the anal fin and represent codes 091729, 071359 , and 091807; 4,798 fish were paint-marked orange and represent codes 091729 and 091748. The 1996-97 broods were PIT-tagged.*

Appendix Table A-4. Release data for subyearling spring chinook salmon reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1991							
071443	5/13/1992	O4A	97,013	50,611	8,392	32.1	80
071444	5/12/1992	O4B	63,585	48,051	8,384	31.2	80
071445	5/12/1992	O5B	63,305	49,498	6,572	32.2	80
071446	5/13/1992	O5A	95,456	50,045	8,195	32.1	80
subtotal			319,359	198,205	31,544	31.9	
071447	5/12/1992	M6A	104,670	50,047	9,877	36.4	80
071448	5/12/1992	M7A	104,929	51,707	9,903	36.3	80
071449	5/11/1992	M6B	109,528	51,518	10,442	38.3	80
071450	5/12/1992	M7B	109,997	51,271	9,816	37.8	80
071451	5/11/1992	M6C	98,617	52,128	10,148	39.2	80
071452	5/11/1992	M7C	108,652	51,659	9,609	36.8	80
subtotal			636,393	308,330	59,256	37.5	
Total			955,752	506,535	90,800	35.6	
1992							
076132	6/1/1993	M6C	113,852	52,893	10,033	28.4	80
076133	6/1/1993	M7C	116,316	52,335	10,372	27.7	80
076134	6/1/1993	M7B	111,333	51,963	10,139	27.9	80
076135	6/1/1993	M6B	109,473	51,680	9,961	28.2	80
076136	6/2/1993	M6A	105,290	52,588	9,127	28.6	80
076137	6/2/1993	M7A	111,103	52,172	9,137	26.9	80
Total			667,367	313,631	58,929	27.6	
1993							
070734	5/20/1994	M6A	140,255	49,726	8,889	30.7	80
070735	5/20/1994	M7A	142,237	52,298	9,217	30.7	80
070736	5/20/1994	M6B	140,227	52,636	9,998	30.3	80
070737	5/20/1994	M7B	142,003	53,172	10,182	30.3	80
070738	5/20/1994	M6C	138,665	51,042	9,872	30.5	80
070739	5/20/1994	M7C	135,990	52,317	9,925	30.5	80
Total			839,377	311,191	58,083	30.4	

[a] *All fish from even numbered brood years were LV fin-clipped and fish from odd numbered brood years were RV fin-clipped. All coded-wire-tagged fish were adipose fin-clipped.*
[b] *Fish from 1991-93 broods were branded.*

Appendix Table A-5. Release data for spring chinook salmon released in the fall. Fish were reared at Umatilla and Bonneville Hatcheries and released in the Umatilla River (IC – Imeques acclimation facility).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
			Bonneville Hatchery				
1991							
076042	11/05/1992	A11	25,104	25,104		13.0	80
076043	11/05/1992	A10/11	25,075	24,992		13.0	80
076044	11/04/1992	A10	15,730	15,423		13.1	80
076045	11/03/1992	A9	24,638	24,638		9.9	80
076046	11/03/1992	A8/9	24,715	24,221		10.0	80
076047	11/03/1992	A8	17,667	17,269		10.1	80
Total			132,929	131,647		11.5	
			Umatilla Hatchery				
1991							
071542	11/05/1992	O3B	50,736	26,135		19.3	80
071543	11/05/1992	O3A	50,680	25,633		19.5	80
Total			101,416	51,768		19.4	
1992							
070155	11/17/1993	O2A	40,661	35,710		18.5	80
070156	11/17/1993	O3A	42,734	33,999		18.8	80
070157	11/17/1993	O2B	39,656	34,857		18.0	80
070158	11/17/1993	O3B	41,244	34,130		19.2	80
subtotal			164,295	138,696		18.6	
070159	11/16/1993	M2A	49,694	34,541		20.3	80
070160	11/17/1993	M3A	49,081	35,408		20.9	80
070161	11/17/1993	M2B	52,211	35,657		21.5	80
070162	11/16/1993	M3B	48,343	35,467		20.2	80
070163	11/17/1993	M3C	49,318	36,157		20.8	80
070216	11/16/1993	M2C	47,867	36,102		20.8	80
subtotal			296,514	213,332		20.8	
Total			460,809	352,028		20.0	

[a] *All fish from even numbered brood years were LV fin-clipped and fish from odd numbered brood years were RV fin-clipped. All coded-wire-tagged fish were adipose fin-clipped.*

Appendix Table A-5 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1993							
070724	11/15/1994	M2C	39,548	34,124		9.0	IC
070725	11/15/1994	M3C	39,517	34,827		9.3	IC
070726	11/15/1994	M2B	39,551	35,156		10.5	IC
070727	11/15/1994	M3B	39,487	34,819		9.2	IC
070728	11/15/1994	M2A	38,234	34,808		9.5	IC
070729	11/15/1994	M3A	40,383	35,160		9.4	IC
subtotal			236,720	208,894		9.6	
070730	11/15/1994	O2A	37,073	34,915		7.2	IC
070731	11/15/1994	O1A	37,096	35,750		7.8	IC
070732	11/15/1994	O2B	32,687	32,251		7.4	IC
070733	11/15/1994	O1B	34,649	34,220		9.6	IC
subtotal			141,505	137,136		8.0	
Total			378,225	345,030		9.0	

Appendix Table A-6. Release data for yearling spring chinook salmon reared at Bonneville, Umatilla, Little White Salmon, and Carson hatcheries and released in the Umatilla River (IC=Imeques acclimation facility).

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
			Bonneville Hatchery				
1991							
071455	3/23/1993	B1	92,728	19,951		14.8	80
071456	3/22/1993	B2	94,220	20,022		14.3	80
Total			186,948	39,973		14.5	
1992							
070250	3/25/1994	B6	99,616	26,716		11.7	80
070251	3/25/1994	B5	101,830	26,305		11.7	80
075944	3/25/1994	B8	103,980	20,109	4,818	12.5	80
075945	3/25/1994	B7	99,676	20,219	5,200	12.2	80
Total			405,102	93,349	10,018	12.0	
1993							
070649	4/21/1995	B7	123,257	22,189	5,137	10.5	80
070650	4/21/1995	B8	124,614	24,088	4,878	10.2	80
070660	3/13/1995	B5	74,735	23,607		13.9	80
070661	4/14/1995	B6	74,921	28,765		11.4	80
Total			397,527	98,649	10,015	11.2	
			Umatilla Hatchery				
1991							
075739	3/23/1993	O5B	50,312	21,499	5,300	8.2	80
075740	3/23/1993	O4B	50,109	20,880	4,934	8.1	80
075741	3/24/1993	O4A	54,347	21,157	5,548	8.3	80
075742	3/24/1993	O5A	54,014	20,307	5,242	8.6	80
Total			208,782	83,843	21,085	8.3	
1992							
070217	3/21/1994	O5A	51,210	20,070	5,082	8.5	80
070218	3/21/1994	O5B	49,375	19,920	5,142	8.1	80
070219	3/21/1994	O4B	52,620	20,971	5,151	8.8	80
070220	3/22/1994	O4A	51,938	20,982	5,419	8.4	80
Total			205,143	81,943	20,797	8.5	

[a] *All fish from even numbered brood years were LV fin-clipped and fish from odd numbered brood years were RV fin-clipped. All coded-wire-tagged fish were adipose fin-clipped.*
[b] *Fish from 1991-93 broods were branded.*

Table A-6 (continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1993							
071453	3/13/95	M5A	50,007	20,315	4,910	8.3	80
071454	3/13/95	M5B	40,685	15,661	4,436	8.9	80
subtotal			90,692	35,976	10,015	7.8	
070651	3/13/95	O4A	49,001	18,864	5,176	9.1	80
070652	3/13/95	O4B	44,077	19,052	4,975	8.2	80
070653	3/13/95	O5B	44,188	18,175	5,133	9.0	80
070654	3/13/95	O5A	47,846	19,091	5,063	8.7	80
subtotal			185,112	75,182	20,347	8.0	
Total			275,804	111,158	29,673	7.9	
1994							
071027	3/13/96	M6A	49,032	19,622	5,083	9.0	IC
071028	3/13/96	M6B	45,887	18,844	4,682	10.8	IC
071029	3/13/96	M6C	49,121	19,258	5,275	9.0	IC
subtotal			144,040	57,724	15,040	9.6	
071030	3/13/96	O4A	60,599	19,961	4,531	7.5	IC
071031	3/13/96	O5A	60,137	20,066	5,026	8.8	IC
071032	3/13/96	O5B	57,076	19,874	5,092	8.7	IC
071033	3/13/96	O4B	56,709	19,583	4,232	9.5	IC
subtotal			234,521	79,484	18,881	8.6	
Total			378,561	137,208	33,921	9.0	
1995							
091730[a]	3/26/97	O4A	57,668	19,842	3,724	9.3	IC
091750	3/26/97	O4B	56,901	20,289		9.3	IC
091749	3/26/97	O5A	56,764	19,818		8.9	IC
091751	3/26/97	O5B	54,550	20,597		8.9	IC
Total			225,883	80,546		9.1	
1996							
092256	3/8/98	M2A	52,159	23,162	248	11.2	IC
092257	3/8/98	M2B	51,972	22,788	243	11.2	IC
092258	3/8/98	M2C	51,743	22,450	240	11.5	IC
subtotal			155,874	68,400	731	11.3	
092259	3/8/98	O5A	60,277	23,247	237	11.8	IC
092260	3/8/98	O4A	59,744	22,759	247	11.9	IC
092261	3/8/98	O5B	53,502	23,248	233	11.9	IC
092262	3/8/98	O4B	53,317	23,778	244	12.0	IC
subtotal			226,840	93,032	961	11.9	
Total			382,714	161,432	1,692	11.7	

[a] All fish from even numbered brood years were LV fin-clipped and fish from odd numbered brood years were RV fin-clipped. All coded-wire tagged fish were adipose fin-clipped.
[b] Fish from 1991-94 broods were branded; 1995 brood was paint-marked (3,724) green on the anal fin. Mark represents tag codes 091730, 091750, and 091751; 1996 brood was PIT-tagged.

Table A-6 (continued)

Brood year, CWT code	Release date	Race-way	Number released[a]	Number CWT	Number brand/paint or PIT-tag[b]	Fish per pound	Release location (RM)
1997							
092414	12/20/1998	O4A	61,849	21,795	243	18.1	IC
092416	12/20/1998	O4B	52,521	21,969	240	18.1	IC
subtotal			114,350	43,754	483	18.1	
092347	3/08/1999	M2A	49,190	20,832	240	13.9	IC
092411	3/08/1999	M2B	48,901	21,741	247	13.4	IC
092412	3/08/1999	M2C	51,017	21,833	240	14.4	IC
subtotal			149,108	64,405	727	13.9	
092413	3/08/1999	O5A	53,403	21,602	241	14.0	IC
092415	3/08/1999	O5B	51,319	21,740	233	12.8	IC
subtotal			104,722	43,342	474	13.4	
Total			368,180	151,501	1,684	15.1	
Little White Salmon Hatchery							
1996							
071420	3/08/1998	39-43	172,999	19,403	235	15.6	80
075743	4/14/1998	34-38	172,258	19,255	244	11.6	80
Total			345,257	38,658	479	13.6	
1997							
076037	3/08/1999	39-43	177,655	17,707	248	16.1	IC
076038	4/14/1999	35-38	124,360	17,993	218	12.7	IC
Total			302,015	35,700	466	14.7	
Carson Hatchery							
1996							
076036	4/14/1998	37-40	99,641	18,721	241	16.3	80
1997							
075746	4/14/1999	37-40	103,761	19,593	248	13.3	IC

[a] *All fish from even numbered brood years through 1996 were LV fin-clipped and fish from odd numbered brood years were RV fin-clipped. All coded-wire tagged fish were adipose fin-clipped. CWT fish from the 1997 brood at Little White Salmon and Carson hatcheries were adipose and LV fin-clipped. Non-CWT fish from the 1997 brood at Umatilla Hatchery were unmarked.*

[b] *1996 brood was PIT-tagged.*

Appendix Table A-7. Release data for summer steelhead reared at Umatilla Hatchery and released in the Umatilla River (RM= river mile; acclimation facilities: BS - Bonifer Springs acclimation facility, RM=63.5; MC - Meacham Creek; MN - Minthorn Springs acclimation facility, RM=68.5; TH - Thornhollow acclimation facility, RM=68.5)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[a]	Fish per pound	Release location (RM)
1991							
075840	5/01/1992	M5A	22,288	10,105		5.5	MC
075838	5/01/1992	M5A	22,469	10,562		5.5	MC
075839	5/01/1992	M5A	22,662	10,275		5.5	MC
075841	4/30/1992	M5B	22,262	10,108		5.0	MC
075842	4/30/1992	M5B	21,365	9,498		5.0	MC
075843	4/30/1992	M5B	20,923	9,747		5.0	MC
074127	3/29/1992	M5C	22,059	10,203		5.8	BS & MN
073862	3/29/1992	M5C	22,902	10,594		5.8	BS & MN
073759	3/29/1992	M5C	22,474	10,394		5.8	BS & MN
Total			199,404	91,486		5.4	
1992							
076052	5/13/1993	M5A	65,465	13,117	9,055	6.1	BS
076053	5/13/1993	M5A		11,410		6.1	BS
076054	5/13/1993	M5A		9,907		6.1	BS
076055	4/16/1993	M5B	47,979	10,031	9,641	5.6	MN
076056	4/16/1993	M5B		9,418		5.6	MN
076057	4/16/1993	M5B		9,643		5.6	MN
076058	4/18/1993	M5C	44,824	10,194	8,863	4.5	BS
076059	4/18/1993	M5C		9,792		4.5	BS
076060	4/18/1993	M5C		9,440		4.5	BS
Total			158,268	92,952	27,559	5.5	
1993							
070139	5/12/1994	M5A	26,411	8,595	7,700	5.2	BS
070140	5/12/1994	M5A	25,686	8,400		5.2	BS
070141	4/14/1994	M5B	24,692	9,952	7,827	5.1	MN
070142	4/14/1994	M5B	24,906	9,965		5.1	MN
070143	4/11/1994	M5C	26,481	10,470	7,718	4.9	BS
070144	4/11/1994	M5C	24,922	9,651		4.9	BS
Total			153,098	57,034	23,346	5.1	
1994							
070655	5/12/1995	M8A	47,941	19,782	8,908	5.5	BS
070656	4/13/1995	M8B	49,983	18,812	8,134	4.7	MN
070657	4/11/1995	M8C	48,539	19,290	7,771	5.6	BS
Total			146,463	57,884	24,813	5.3	
1995							
071034	5/9/1996	M8A	49,783	20,633	8,896	5.1	TH
071035	4/12/1996	M8B	47,543	19,742	8,615	5.1	MN
071036	4/24/1996	M8C	49,377	21,205	8,827	5.3	BS
Total			146,703	61,580	26,338	5.3	

[a] *All fish were adipose clipped and all CWT fish were also left ventral fin-clipped*

Appendix Table A-7 (continued)

Brood year, CWT code	Release date	Race-way	Number released	Number CWT	Number brand/paint or PIT-tag[a]	Fish per pound	Release location (RM)
1996							
091837[b]	5/15/1997	M8A	48,944	20,065	8,655	4.9	BS
091836	4/11/1997	M8B	46,788	19,103		4.6	MN
091835[c]	4/10/1997	M8C	41,555	19,531		5.4	BS
Total			137,287	58,699	8,655	4.9	
1997							
092339	5/4/1998	M8A	47,313	19,468	242	5.5	BS
092340	4/17/1998	M8B	49,084	20,646	244	4.7	MN
092341	4/16/1998	M8C	41,088	20,800	250	5.9	BS
Total			137,485	60,914	736	5.3	
1998							
092527	5/4/1999	M8A	35,564	19,088	288	5.9	BS
092526	4/14/1999	M8B	41,843	20,787	210	4.9	MN
092525	4/13/1999	M8C	44,226	20,450	198	5.5	BS
Total			121,633	60,325	696	5.4	

[b] *Fish from the 1996 brood were paint marked with orange (1,511), mustard yellow (5,003), and red (2,141) on the anal fin. Fish from the 1997 brood were PIT-tagged.*

[c] *Approximately 5,000 fish were released on 051597.*

Appendix Table A-8. Numbers of spring and fall chinook salmon, coho salmon, and steelhead counted at Three Mile Falls Dam, 1981 to present (chinook subjacks were <381 mm FL; chinook jacks were 382-610 mm FL; coho jacks were <508 mm FL).

	Spring chinook salmon			Fall chinook salmon			
Year	Jack	Adult	Total	Subjack	Jack	Adult	Total
1985					79	6	85
1986					407	28	435
1987				195	139	53	387
1988		13	13	1,268	195	91	1,554
1989	96	68	164	65	267	271	603
1990	32	2,158	2,190	618	113	329	1,060
1991	36	1,294	1,330	273	468	522	1,263
1992	3	461	464		64	239	303
1993	16	1,205	1,221	15	27	370	412
1994	8	263	271	368	236	688	1,292
1995	108	388	496	338	288	603	1,229
1996	121	2,152	2,273	606	80	646	1,332
1997	4	2,194	2,198	189	207	354	750
1998	20	409	429	230	154	286	670
1999	210	1,764	1,974	152	137	737	1,026
Average	59	1,031	1,085	332	191	348	827

	Steelhead				Coho Salmon		
Run year	Hatchery	Wild	Total	Year	Jack	Adult	Total
1981-82			768	1982			
1982-83			1,264	1982			
1983-84			2,314	1983			
1984-85			3,197	1984			
1985-86			2,885	1985			
1986-87			3,444	1986			
1987-88	165	2,315	2,480	1987	29		29
1988-89	370	2,104	2,474	1988	746	936	1,682
1989-90	245	1,422	1,667	1989	479	4,154	4,633
1990-91	387	724	1,111	1990	515	409	924
1991-92	522	2,247	2,769	1991	189	1,732	1,921
1992-93	616	1,297	1,913	1992	173	356	529
1993-94	345	945	1,290	1993	18	1,531	1,549
1994-95	656	875	1,531	1994	62	984	1,046
1995-96	785	1,296	2,081	1995	53	946	999
1996-97	1,463	1,014	2,477	1996	24	618	642
1997-98	903	862	1,765	1997	137	670	807
1998-99	751	1,135	1,886	1998	192	3,081	3,273
Average	678	1,373	2,084		218	1,402	1,342

Appendix Table A-9. Number and percent of PIT-tagged subyearling fall chinook salmon released in the Umatilla River that were detected at interrogation and recovery sites throughout the Columbia Basin, brood years 1998-99.

Brood Year	Raceway	Detection sites: Uma-tilla River	John Day Dam	Bonne-ville Dam	Estu-ary	Cres-cent Island	Rice Island	Three Mile Island	Total No. (%)	Total First-time No. (%)
1997	M2A	8	34	15	0	0	0	3	60(11.5)	56(10.8)
	M2B	10	26	11	0	1	2	1	51(10.1)	46(9.1)
	M2C	17	29	7	0	0	0	1	54(10.6)	52(10.2)
	M3A	8	24	17	0	0	2	1	52(10.5)	48(9.7)
	M3B	12	27	18	0	0	1	1	59(11.6)	53(10.4)
	M3C	15	28	13	0	0	2	0	58(11.4)	58(11.4)
	M4A	15	21	6	0	0	2	0	44(8.7)	41(8.1)
	M4B	15	31	12	0	0	3	0	61(12.0)	55(10.8)
	M4C	15	26	16	0	0	5	3	65(12.8)	60(11.8)
		115	246	115	0	1	17	10	504(11.0)	469(10.3)
1998	M2A	118	55	30	0				203(34.4)	162(27.5)
	M2B	140	59	32	0				231(39.5)	185(31.6)
	M3A	144	52	25	0				221(37.9)	175(30.0)
	M3B	144	69	25	0				238(40.9)	192(33.0)
	M4A	153	45	21	0				219(38.8)	187(33.2)
	M4B	128	49	25	0				202(34.5)	163(27.9)
		827	329	158	0				1314(37.7)	1064(30.5)

Appendix Table A-10. Number and percent of PIT-tagged yearling fall chinook salmon released in the Umatilla River that were detected at interrogation and recovery sites throughout the Columbia Basin, migration years 1998-1999.

Brood Year	Raceway	Detection sites: Uma-tilla River	John Day Dam	Bonne-ville Dam	Estu-ary	Cres-cent Island	Rice Island	Three Mile Island	Total No. (%)	Total First-time No. (%)
				Willard Hatchery						
1996	41	19	15	10	2	0	2	0	48(22.9)	36(17.1)
	42	34	23	9	4	0	3	0	73(31.7)	66(28.7)
		53	38	19	6	0	5	0	121(27.5)	102(23.2)
				Bonneville Hatchery						
1996	11	3	14	7	0	1	0	0	25(11.5)	24(11.1)
1997	Release 1	61	27	6	2				95(38.3)	80(32.3)
	Release 2	63	36	14	1				114(48.3)	94(39.8)
		124	63	20	2				209(43.2)	209(36.0)

Appendix Table A-11. Number and percent of PIT-tagged spring chinook salmon released in the Umatilla River that were detected at interrogation and recovery sites throughout the Columbia Basin, migration years (MY) 1998-1999.

Brood Year	Raceway	Detection sites: Umatilla River	John Day Dam	Bonneville Dam	Estuary	Crescent Island	Rice Island	Three Mile Island	Total No. (%)	Total First-time No. (%)
					Umatilla Hatchery					
1996	O4A	4	20	10	1	0	1	0	36(14.6)	31(12.6)
	O4B	4	27	11	0	0	3	0	45(18.4)	42(17.2)
	O5A	8	9	6	0	1	3	0	27(11.4)	21(8.9)
	O5B	6	18	12	1	1	4	0	42(18.0)	42(18.0)
	M2A[a]	9	30	9	1	0	3	0	53(21.4)	49(19.8)
	M2B	7	18	14	1	0	3	0	43(17.7)	37(15.2)
	M2C	4	21	12	1	0	6	0	44(18.3)	40(16.7)
		42	143	74	5	2	23	0	290(17.1)	262(15.5)
1997	O4A[b]	5	10	2	0				17(7.0)	15(6.2)
	O4B[b]	4	8	3	2				17(7.1)	15(6.3)
	O5A	17	36	16	0				69(28.6)	56(23.2)
	O5B	18	37	17	0				72(30.9)	62(26.6)
	M2A	15	25	9	0				49(20.4)	39(16.3)
	M2B	14	38	12	0				64(25.9)	54(21.9)
	M2C	19	37	15	0				71(29.6)	63(26.3)
		92	191	74	2				359(21.3)	304(18.1)
					Little White Salmon Hatchery					
1996	46	12	7	4	2	0	1	0	26(11.1)	22(9.4)
	48	26	25	10	0	0	5	1	67(27.5)	58(23.8)
		38	32	14	2	0	6	1	93(19.4)	80(16.7)
1997	39-43	20	21	9	2				52(21.0)	44(17.7)
	35-38	56	32	12	0				100(45.7)	77(35.2)
		76	53	21	2				152(32.5)	121(25.9)

[a] *There was an additional fish detected at McNary Dam (not listed) on 05/29/98. It was detected at John Day Dam three days later.*

[b] *These groups were emergency released in late-December, approximately 4 months prior to water-up of mainstem PIT tag detection facilities.*

Appendix Table A-11(continued)

Brood year	Raceway	Detection sites: Umatilla River	John Day Dam	Bonneville Dam	Estuary	Crescent Island	Rice Island	Three Mile Island	Total No. (%)	Total First-time No. (%)
					Carson Hatchery					
1996	37-40	27	29	15	0	0	0	0	71(29.5)	58(24.1)
1997	37-40	63	45	13	1				122(49.2)	99(39.9)

Appendix Table A-12. Number and percent of PIT-tagged summer steelhead released in the Umatilla River that were detected at interrogation and recovery sites throughout the Columbia Basin, migration years 1998-99.

Brood year	Raceway (release site)	Detection sites: Umatilla River	John Day Dam	Bonneville Dam	Estuary	Crescent Island	Rice Island	Three Mile Island	Total No. (%)	Total First-time No. (%)
1997	M8A (Bon)	6	21	11	1	1	8	0	48(19.8)	44(18.2)
	M8B (Min)	5	44	24	1	0	13	1	88(36.1)	74(30.3)
	M8C (Bon)	2	44	20	0	0	11	0	77(30.8)	63(25.2)
		13	109	55	2	1	32	1	213(28.9)	181(24.6)
1998	M8A (Bon)	29	16	6	1				52(18.1)	45(15.6)
	M8B (Min)	28	31	17	0				76(36.2)	52(24.8)
	M8C (Bon)	24	13	8	1				46(23.2)	33(16.7)
		81	60	31	2				174(25.0)	130(18.7)

REPORT B

Fish Health Monitoring and Evaluation

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INTRODUCTION

This report presents findings and results for the eighth year of Fish Health Monitoring and Evaluation in the Umatilla Hatchery program. As in previous reports, specific broodstock information for juveniles in this report are found in previous annual reports. Broodstock fish health status and information available in this report will have implications for the health of juveniles in future annual reports. This is especially true for known vertically transmitted (parent to progeny) diseases like bacterial kidney disease (BKD). As an example, results from the BY97 Umatilla River spring chinook spawned for the first time at the South Fork Walla Walla adult facility in 1997 were reported in the 1997 BPA annual report (Groberg et al. 1999). This annual report summarizes the 97 brood year juvenile fish health profile through the hatchery phase to acclimation and release into the Umatilla River in the spring of 1999.

Results from the third year of Umatilla River spring chinook broodstock monitoring at the South Fork Walla Walla adult facility are included in this report. These data continued to provide information regarding juvenile *Renibacterium salmoninarum* infection levels and adult BKD ELISA profiles. Fall chinook broodstock monitoring continued for the third year at the Three Mile Dam adult facility. Umatilla River summer steelhead broodstock monitoring was once again conducted at Minthorn Ponds.

The details of fish health monitoring plans for the Umatilla Hatchery program are included in the Umatilla Hatchery and Basin Annual Operation Plan (AOP) and Project Work Statement. Through cooperative efforts with the Confederated Tribes of the Umatilla Indian Reservation (CTUIR), we have continued to monitor fish health at Umatilla Hatchery and at the many acclimation facilities along the Umatilla River following transfer. These facilities also acclimate yearling fall and spring chinook reared at Lower Columbia River hatcheries. Results from fish health examinations of these fish at the acclimation sites are included in this report for the 1997 brood year smolts.

METHODS

Previously described methods referred to in other annual reports were used for the Umatilla Hatchery Fish Health Monitoring and Evaluation project (Keefe et al. 1993, Keefe et al. 1994, and Groberg et al. 1996 and 1997). Recent changes to any of these methods were described in the 1998 annual report (Onjukka et al. 1999).

Juvenile Monthly Monitoring

Methods described in previous annual reports referred to above were used.

Juvenile Preliberation Monitoring

Methods described in previous annual reports referred to above were used.

Juvenile Disease Outbreak Monitoring

Dead fish were examined and kidney tissues were inoculated onto TYE-S agar plates. Diagnostic procedures generally followed the guidelines in the Fish Health Section Bluebook (Thoesen, 1994).

Prophylactic Treatments

Two prophylactic feedings of erythromycin (Aquamycin) were given to juvenile spring chinook salmon under the Investigational New Animal Drug (INAD) process. Veterinary prescriptions were obtained for the use of formalin on summer steelhead and spring chinook salmon adults at adult holding facilities for the Umatilla program. Erythromycin and oxytetracycline injections were given to adult spring chinook salmon at the Three Mile Dam and South Fork Walla Walla adult facilities under a prescription. These injections were administered at 10 mg/kg for oxytetracycline and at 20 mg/kg for erythromycin. Initial injections were given upon collection at Three Mile Dam. A second injection was given in mid July for fish that arrived by early July; fish arriving after early July received only one injection.

Broodstock Monitoring

Umatilla River steelhead were sampled at Minthorn Ponds for the 99 brood production at Umatilla Hatchery. Priest Rapids 98 brood fall chinook salmon were sampled on November 16, 1998 by Washington Department of Fish & Wildlife (WDFW) fish health personnel. Umatilla River 98 brood fall chinook salmon adults for Bonneville Hatchery production were sampled at Three Mile Dam adult facility on November 3, 9, 12, 16, 20 and 24, 1998. Umatilla River 99 brood spring chinook salmon were sampled for Umatilla Hatchery production at the South Fork Walla Walla adult facility on August 24, 31 and September 7 and 14, 1999.

RESULTS

Juvenile Monthly Monitoring

Necropsies: External parasites were not detected in twenty-four moribund/fresh-dead and 38 grab-sampled healthy fish examined for external parasites and gill condition by wet mount microscopy. Occasional observations were made of clubbed gill tips, hyperplastic filaments and gill aneurysms; however, overall gill condition was good for all stocks.

The fish pathogen *Flavobacterium psychrophilum* (CWD bacteria) was detected systemically in 7/18 (38.9%) moribund/fresh-dead steelhead, 1/21 (4.8%) fall chinook salmon and 4/89 (4.5%) spring chinook salmon examined (Appendix Tables A-4, A-5, and A-6). Yellow pigmented bacteria were isolated from gill cultures of moribund/fresh-dead fish in 2/7 (28.6%) steelhead, 3/21 (14.3%) fall chinook salmon and 1/35 (2.9%) spring chinook salmon (Appendix Tables A-4, A-5, and A-6). Of all the fall chinook salmon gill bacteria tested, only one culture was confirmed to be *F. psychrophilum*.

All moribund/fresh-dead fish were observed for any signs of BKD or any other disease. There were no mortalities of any species with gross signs of BKD in the kidney. Mortalities occasionally had one or more of the following: fungus tail, scoliosis, pumpkin seed shape, eyes missing, opaque eyes, darkened coloration, and hemorrhaged vent.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT: Twenty-one moribund/fresh-dead and 20 grab-sampled 98 brood year Priest Rapids fall chinook salmon, programmed as sub-yearlings, were examined for the presence of Rs bacteria by the direct fluorescent antibody test (DFAT) during monthly monitoring in March and April 1999. All DFAT results were negative (Appendix Table A-7).

Seventeen moribund/fresh-dead and five grab-sampled healthy appearing 97 brood year Umatilla River spring chinook salmon were tested for the presence of Rs bacteria by the DFAT; all results were negative (Appendix Table A-8). Sixty-seven moribund/fresh-dead and 70 grab-sampled fish were examined for Rs antigen by ELISA from July-December 1998. All Rs ELISA values were ≤ 0.051 OD units (negative or low level) (Appendix Table A-8).

Juvenile Preliberation Monitoring

Necropsies: Sub-samples of all species and stocks reared at Umatilla Hatchery were examined for external parasites and gill condition. External parasites were not detected on 23 grab-sampled and three moribund fish. Thirty 98 brood year fall chinook salmon subyearlings and 50 97 brood year spring chinook salmon were tested for infectious hematopoietic necrosis virus (IHNV) or any other replicating agents; none were detected.

Results from spring chinook stocks destined to Umatilla River from Lower Columbia facilities in 1999 can be found in fish health inspection reports from the Lower Columbia River Fish Health Center (Gutenberger, 1999).

On March 8, 1999, the 97 brood year Umatilla River spring chinook salmon that had been reared at Umatilla Hatchery were released from the Imeques C-mem-ini-kem acclimation facility (pond 1 and 2). Mortalities and grab-sampled fish were collected and provided by CTUIR personnel for examinations. Systemic bacteria were not detected in kidney smear cultures. There were no signs of BKD in 10 moribund/fresh-dead and 10 grab-sampled fish.

Also on March 8, 1999, the 97 brood year Carson spring chinook salmon reared at Little White Salmon NFH were released from the Imeques C-mem-ini-kem acclimation facility (pond 4). Mortalities and grab-sampled fish were collected and provided by CTUIR personnel for examinations. One of five (20%) moribund/fresh-dead fish had a gray kidney indicative of BKD.

On April 7, 1999, the 97 brood year Carson spring chinook salmon that had been reared at Carson NFH were examined at the Imeques C-mem-ini-kem acclimation facility from pond 2. Erythrocytic inclusion body syndrome (EIBS) was not detected in any of the five grab-sampled fish. The protozoan parasite *Ambiphrya (Scyphidia)* was detected from body scrapings in one of five (20%) fish examined. Moribund or fresh-dead fish were not available from this group.

Also on April 7, 1999 at the Imeques C-mem-ini-kem acclimation facility, we examined one moribund/fresh-dead and five grab-sampled 97 brood year Carson spring chinook salmon that had been reared at Little White Salmon NFH. Low to moderate levels of *Ambiphrya* were detected in all five grab-sampled fish. All fish were negative for EIBS.

On March 11, 1999 a preliberation/increased-loss examination was conducted on the 97 brood year Bonneville fall chinook salmon yearlings at the Thornhollow acclimation facility. Low levels of *Ambiphrya* were detected in 1/5 (20%) grab-sampled fish. Seven of 10 (70%) moribund/fresh-dead fish had gross signs of BKD. *Flavobacterium psychrophilum* was isolated from kidney cultures at moderate to high levels in 6/10 (60%) moribund/fresh-dead fish. Heavy levels of *F. psychrophilum* were also detected from gill cultures of 1/10 (10%) moribund/fresh-dead fish. Blood smears were negative for EIBS inclusions, however, increased basophilic inclusions were noted in 5/10 (50%) grab-sampled fish. Two of these grab-sampled fish had pale blood (anemia) and heavy levels of Rs bacteria were observed in the blood smears.

On April 7, 1999 a preliberation/increased-loss examination was conducted on the later release group of 97 brood year Bonneville fall chinook salmon yearlings at the Thornhollow acclimation facility. Loss was reported to be approximately 15-20 fish per day. Gross signs of BKD were noted on 7/10 (70%) moribund/fresh-dead fish. EIBS or external parasites were not observed in 10 grab-sampled fish and kidney cultures were negative for *F. psychrophilum*.

On June 3, 1999 a preliberation examination was conducted on the 98 brood year Priest Rapids fall chinook sub-yearlings at the Imeques C-mem-ini-kem acclimation facility. Losses were reported to be above normal levels. Approximately 25% of moribund/fresh-dead fish had eroded and fungus covered caudal areas. Ten of 18 (55.5%) moribund/fresh-dead fish had systemic *Yersinia ruckeri* (Enteric Redmouth) bacterial infections and four of those were at moderate to high levels. External parasites were not observed in three moribund fish examined.

Assays for *Renibacterium salmoninarum* by the ELISA and DFAT: Thirty grab-sampled 98 brood year Priest Rapids sub-yearling fall chinook salmon from each of three Michigan raceways (M2B, M3B and M4B) were sampled at Umatilla Hatchery. There was no evidence of an Rs infection problem. All Rs ELISA values were ≤ 0.031 OD units (Appendix table A-9). No statistical analysis was necessary since the results for each raceway were so similar.

Thirty grab-sampled 97 brood year Umatilla River yearling spring chinook salmon from each raceway of Oregon series O5 (A and B) and Michigan series M2 (A,B and C) were sampled at Umatilla Hatchery. None of the 150 fish examined had any indication of an Rs infection problem. All ELISA values were ≤ 0.046 OD units (Appendix Table A-10). No statistical analysis was necessary since the results for each raceway were so similar.

At the Imeques C-mem-ini-kem acclimation facility this same 97 brood year Umatilla River spring chinook salmon stock was examined at the tail end of the acclimation period on March 8, 1999. Five moribund/fresh-dead and five grab-sampled smolts were sampled from each of two ponds (pond 1 and 2). There was no evidence of an Rs infection problem at preliberation. All ELISA values were ≤ 0.042 OD units (Appendix Table A-11).

The 97 brood year Carson spring chinook salmon yearlings were examined prior to release at the Imeques C-mem-ini-kem acclimation facility. Five moribund/fresh-dead and five grab-sampled smolts that had been reared at Little White Salmon NFH were sampled from pond 4 on March 8, 1999. All ELISA values from grab-sampled fish were ≤ 0.034 OD units. One of five (20%) moribund/fresh-dead fish had a clinical ELISA value of 3.028 OD units (Appendix Table A-12). Five grab-sampled smolts that had been reared at Carson NFH were sampled from Pond 2 on April 7, 1999. All ELISA values were ≤ 0.035 OD units (Appendix Table A-13). One moribund/fresh-dead and five grab-sampled smolts that had been reared at Little White Salmon NFH were sampled from pond 3 on April 7, 1999. One of five (20%) grab-sampled fish had a high ELISA value of 0.794 OD units and all other fish had values ≤ 0.073 OD units (Appendix Table A-14).

A pre-transfer examination was conducted on the 97 brood year Bonneville fall chinook salmon yearlings at Bonneville Hatchery on January 28, 1999. Ten of 116 (8.6%) grab-sampled fish had a significant level of Rs antigen with ELISA values ≥ 0.200 OD units. Five of these were ≥ 0.500 OD units including one clinical level at 1.815 OD units (Leslie Lindsay, ODFW Corvallis Fish Pathology personal communication).

On March 11, 1999 the 97 brood year Bonneville fall chinook salmon smolts were sampled from each of two ponds (pond 1 and 2) at the Thornhollow acclimation facility. Three of five (60%)

moribund/fresh-dead fish from each pond had clinical BKD with ELISA values ≥ 2.724 OD units and all others had values ≤ 0.085 OD units (Appendix Table A-15). One of five (20%) grab-sampled fish from pond 1 had a clinical value of 3.021 OD units and one of five (20%) had a moderate value of 0.526 OD units. All other grab-sampled fish had ELISA values ≤ 0.065 OD units.

On April 7, 1999 at the Thornhollow acclimation facility, a preliberation/increased-loss examination was conducted on the later release group of 97 brood year Bonneville fall chinook salmon smolts. Four of five (80%) moribund/fresh-dead fish from pond 1 and 2/5 (40%) from pond 2 had clinical ELISA values ≥ 2.737 OD units and all others had values ≤ 0.068 OD units (Appendix Table A-16). One of five (20%) grab-sampled fish from pond 1 had a moderate ELISA value of 0.388 OD units and all other grab-sampled fish had ELISA values ≤ 0.049 OD units.

Juvenile Disease Outbreak Monitoring

An increased loss examination was conducted on March 3, 1999 to investigate the cause of mortality in the 98 brood year Priest Rapids fall chinook salmon programmed as sub-yearlings at Umatilla Hatchery. Twelve of 16 (75.0%) moribund/fresh-dead fish from raceways O2A, O2B and O3A had coagulated yolk. Fungus tails were noted on 10/16 (62.5%) of these fish. Aeromonad-pseudomonad bacteria were also detected at varying levels in 12/16 (75.0%) fish examined. This loss was determined to be caused by a combination of coagulated yolk and fungus tail. Mortality rates were as high as 0.1%/day in raceways O2A and O3A but subsided to normal levels in all raceways.

Prophylactic Treatments

Oral erythromycin (Aquamycin) medicated feeding regimes were administered twice through INAD protocols to the 97 brood year Umatilla River spring chinook salmon programmed as yearlings. Both feedings were for 28 days at a target dosage of 100 mg/kg. The first feeding (2.25% erythromycin) started on May 29, 1998 and ended on June 25, 1998. Lethal and non-lethal signs of toxicity were observed on the first day of toxicity testing. One of 60 (1.7%) fish died on this day displaying arched back and a rigid spinal column. Five of 60 (8.3%) fish displayed the same signs but without mortality. The only other signs of toxicity were on day seven of toxicity testing when 4/60 (6.7%) fish displayed the same signs with no mortality. The second feeding (4.5% erythromycin) started on December 4, 1998 and ended on January 2, 1999. Lethal and non-lethal signs of toxicity were observed on the first and third day of toxicity testing. One fish displayed non-lethal signs of toxicity on day seven. Nine of 220 (4.1%) died with arched back and rigid spinal column and 58/220 (26.4%) displayed the same signs but without mortality. One of 220 (0.4%) fish displayed abnormal swimming behavior and 3/220 (1.4%) fish had bruising or skin discoloration all without mortality.

Broodstock Monitoring

Forty-one BY99 Umatilla River summer steelhead females and 39 males were sampled individually for culturable viruses. Three of 41 (7.3%) ovarian fluid samples and 2/16 (12.5%) pyloric caeca/kidney/spleen (PKS) sample pools were positive for infectious hematopoietic necrosis virus (IHNV) (Appendix Table A-17). A high prevalence of external fungus was noted on adult mortality with 19/27 (70.3%) having the entire body covered with fungus.

Sixty BY98 Priest Rapids fall chinook salmon spawners were sampled for IHNV and any culturable viruses; all were negative (Appendix Table A-18).

Seventy-nine BY98 Umatilla River fall chinook salmon female spawners were sampled for Rs antigen by the ELISA (Appendix Table A-19). All ELISA values were in the lowest OD range (0.0-0.099). One of 10 (10%) adult mortalities had a low ELISA value in the 0.100-0.199 OD range and all other values were ≤ 0.099 OD units (Appendix Table A-20). Three of 10 (30%) adult mortalities had moderate to high level systemic infections of *Aeromonas salmonicida*, the causative agent of furunculosis. *Flavobacterium psychrophilum* (CWD bacteria) was also detected in 3/10 (30%) adult mortalities at moderate levels. Seventy-two female spawners were sampled for IHNV and culturable viruses; all were negative (Appendix Table A-21).

Three hundred eighty-two BY99 Umatilla River spring chinook salmon spawners and 28 adult mortalities were sampled for Rs antigen by the ELISA (Appendix Tables A-22 and A-23). There was a lack of evidence for a significant Rs infection problem in this brood year. Three of 276 (1.1%) spawned females had low level ELISA values in the 0.100-0.199 range and 1/276 (0.4%) was in the 0.200-0.399 range. All 106 male values were ≤ 0.099 OD units. All 28 adult mortality had ELISA values ≤ 0.099 OD units. Infectious hematopoietic necrosis virus (IHNV) was isolated from 29/69 (42%) individual ovarian fluid samples and 8/15 (53.3%) pyloric caeca/kidney/spleen (PKS) sample pools (Appendix Table A-24). This was the first time IHNV has been isolated from this stock at the South Fork Walla Walla adult facility.

Two hundred thirty-seven BY99 spawners at the South Fork Walla Walla adult facility were identified by origin using coded wire tag recovery data. These fish were analyzed for Rs antigen by the ELISA (Appendix Table A-25). One of two hundred sixteen (0.5%) 95 brood year fish from Oregon raceways at Umatilla Hatchery had a low level ELISA value in the 0.200-0.399 range. All 96 brood year fish from Oregon raceways (N=6), Michigan raceways (N=14) and one reared at Little White Salmon NFH had ELISA values ≤ 0.099 OD units. Statistical analysis was not conducted since there were no 95 brood year Michigan raceways and so few fish for comparison with 96 brood year fish. Additionally, since all ELISA values were so low (≤ 0.099 OD units) there was no need for statistical analysis.

DISCUSSION

Monitoring for pathogens and parasites in juveniles reared at Umatilla Hatchery during this report period continued with similar findings as in previous reports with one exception relating to the absence of BKD which will be discussed in the next paragraph. There were no losses attributed to systemic bacterial infections. However, as in other years of monitoring, *F. psychrophilum* or CWD bacteria were isolated during routine culture of moribund/fresh-dead fish (Appendix Tables A-4, A-5 and A-6).

The one exception to reporting of similar findings over previous years at Umatilla Hatchery is the positive noteworthy lack of clinical BKD or even one moderate level of Rs antigen by the ELISA in the 97 brood year Umatilla River spring chinook juveniles monitored throughout rearing to release. The first year that Umatilla Hatchery utilized Umatilla River returns spawned at the South Fork Walla Walla adult facility for broodstock was in 1997. This brood year was very "clean" in terms of bacterial kidney disease. Adult spring chinook reared as juveniles at Bonneville and Umatilla Hatcheries, collected in the Umatilla River and spawned in 1997 at South Fork Walla Walla adult facility exhibited low or negative levels of Rs antigen as determined by the ELISA (Groberg et al. 1999). The bottom line to all of this is the fact that vertical transmission of *R. salmoninarum* (BKD) is the primary mechanism of perpetuating this bacterium in the population (Evelyn et al. 1986). If females utilized for broodstock are negative or low level status for Rs antigen, then the risk of having a BKD outbreak or juveniles having clinical BKD are very low. This is especially true for a facility that operates with a pathogen-free water supply such as Umatilla Hatchery. The lack of clinical BKD or even low/moderate ELISA values in the 97 brood year

juveniles implies that there were no significant levels of Rs transmitted to the progeny from the 97 brood year adults.

The overall Rs antigen (BKD) picture by the ELISA has shown that the vast majority (>98%) of the Umatilla River spring chinook spawned at the South Fork Walla Walla adult facility have had negative or only low-level positive values (≤ 0.199 OD units). In three years of monitoring 763 adults (1997-1999), only one case of clinical BKD has been documented. The clinical BKD fish was a BY98 female and the eggs were not used for production (Onjukka et al. 1999). Because the Umatilla River spring chinook have this "clean" BKD history as returning adults, it may be possible to carefully consider reducing the number of scheduled erythromycin (Aquamycin) medicated feedings from two to one at Umatilla Hatchery. From a fish health perspective this would only be possible provided 100% of the female adult chinook salmon were sampled for Rs antigen, and only eggs from females with ELISA values ≤ 0.199 OD units were used for production.

Umatilla River fall chinook salmon adults spawned at Three Mile Dam adult facility have been used for part of the broodstock for the Bonneville yearling fall chinook program since 1996. The high prevalence of BKD in the Bonneville 97 brood year fall chinook mortalities examined at Thornhollow acclimation ponds (Appendix Tables A-15 and A-16) cannot be accounted for by vertical transmission from the fall chinook spawned at Three Mile Dam adult facility because all females sampled in 1997 had ELISA values ≤ 0.112 OD units (Onjukka et al. 1999). A review of egg records indicated that only about 30% of the eggs were from Umatilla River adults while the remaining (approximately 70%) were either Bonneville or Priest Rapids fall chinook adults (Randy Winters, Bonneville Hatchery personal communication). The source of BKD was most likely vertical transmission from the females (approximately 70%) that were not from the Umatilla River fall chinook spawned at Three Mile Dam adult facility. This is supported by ELISA results from a sixty fish sub-sample of the BY97 Bonneville fall chinook female spawners. Five of 60 (8.3%) females had ELISA values ≥ 0.636 OD units and two of these were clinical values at 2.975 and 3.200 OD units (Leslie Lindsay, ODFW Corvallis Fish Pathology personal communication).

The first time isolation of infectious hematopoietic necrosis virus (IHNV) in Umatilla River spring chinook adults at the South Fork Walla Walla adult facility is noteworthy and warrants some discussion. In the first two years of spawning (BY97 and BY98), culturable viruses were not detected in this stock at this facility. However, 42% of the BY99 females sampled were positive for IHNV (Appendix table A-24). This would be considered a high prevalence of IHNV especially for a first time detection. The actual first time IHNV isolation at this facility, however, came in 1998 from the Rapid River adults collected at Lower Granite Dam and hauled to this facility for maturation and spawning. One of 72 (1.4%) females sampled was positive for IHNV. In 1999 the Unmarked Rapid River fish trucked from Lookingglass Creek and held at the South Fork Walla Walla adult facility were positive for IHNV. Three of eight females (37.5%) and 2/14 (14.3) males were positive. All of these IHNV isolates, including Umatilla River summer steelhead isolates from BY95 and BY99, were determined to be Type 2 IHNV isolates using strain-specific 105B monoclonal antibody. A powerful molecular epidemiological tool called ribonuclease (RNase) protection fingerprint analysis can characterize strains based on genetic variations. This type of analysis should be conducted on these isolates and any new isolates from this basin. Studies using this epidemiological tool have been conducted on IHNV isolates in the Deschutes River watershed in Oregon (Anderson et al. 2000). A better understanding of the genetic variation of IHNV strains will improve awareness of a potential highly virulent new strain which could cause greater risk to fish restoration efforts in the Umatilla Basin.

The high prevalence (55.5%) of *Y. ruckeri* (Enteric Redmouth) bacteria in moribund/fresh-dead 98 brood year Priest Rapids fall chinook sub-yearlings at the Imeques C-mem-ini-kem acclimation ponds

should be noted. Only once has this bacteria been recovered from fish at Umatilla Hatchery and this was in 97 brood summer steelhead (Onjukka et al. 1999). This suggests that the environment at or near the acclimation site was the source of this bacteria. This was probably the case in 1997 at this same location when the 95 bood year Carson spring chinook were found to have a low prevalence (10%) of *Y. ruckeri* in mortalities (Onjukka et al. 1998). This highlights the importance of continued monitoring for pathogens which may cause significant loss, impact outmigration survival, and potentially amplify pathogen loads to fish that are in the natural environment.

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Appendix Table A-1. Number of 98 brood year Umatilla summer steelhead juveniles sampled per raceway in Oregon raceways O2A, O2B, and Michigan series M8 (A, B and C) during monthly monitoring.

Date sampled	O2A[1]	O2B[1]	M8A[1]	M8B[1]	M8C[1]
09-98	ND[3]				
10-98		2			
11-98			1	1	ND[2]
12-98			3	1	ND[2]
01-99			5	ND[2]	ND[2]
02-99			ND[2]	ND[2]	1
03-99			5		

[1] *Moribund or fresh-dead fish.*
[2] *Indicates not done (ND) because no moribund or fresh-dead fish were available.*
[3] *Indicates not done (ND) because fish were being fin-clipped during monthly monitoring, no normal mortality.*

Appendix Table A-2. Number of 98 brood year Priest Rapids fall chinook salmon juveniles, released as subyearlings, sampled per Oregon raceways 02A, 02B, 03A and Michigan raceways M1B, M2B, and M3B during monthly monitoring.

Date sampled	02A[1]	02B[1]	02B[2]	03A[1]	M1B[1]	M1B[2]	M2B[1]	M2B[2]	M3B[1]	M3B[2]
03-99	5	5	5	5						
04-99					1	5	2	5	3	5

[1] *Moribund or fresh-dead fish.*
[2] *Normal, healthy appearing fish.*

Appendix Table A-3. Number of 97 brood year Umatilla River spring chinook salmon juveniles, released as yearlings, sampled per raceway in Oregon series O4 and O5 (A and B), and Michigan series M2 (A, B, and C) during monthly monitoring.

Date sampled	O4A[1]	O4B[1]	O4B[2]	O5A[1]	O5A[2]	O5B[1]	O5B[2]	M2A[1]	M2B[1]	M2C[1]	M2C[2]
06-98				4	5						
07-98				5	5						
08-98	3	1	5	2		ND[3]	5	5	3	3	5
09-98	5	4	5	3		4	5	5	1	4	5
10-98[4]	1	ND[3]	5	1		2	5	3	3	1	5
11-98				5		5	5	1	3	1	5
12-98				1		ND[3]	5	5	4	1	5

[1] *Moribund or fresh-dead fish.*
[2] *Normal, healthy appearing fish.*
[3] *Indicates not done (ND) because no moribund or fresh-dead fish were available*
[4] *Last monthly for fish in Oregon series O4(A and B) since they were transferred early to Imeques C-Mem-ini-Kem acclimation site.*

Appendix Table A-4. Proportions and prevalences (%) of bacterial agents isolated from moribund or fresh-dead 98 brood year Umatilla summer steelhead during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum[3]	APS	
10-98	O2B	0/2	0/2	0/2
11-98	M8A	0/1	0/1	ND[4]
	M8B	0/1	0/1	ND[4]
	M8C	ND[4]	ND[4]	ND[4]
12-98	M8A	2/3 (66.7%)	0/3	1/2 (50%)
	M8B	1/1 (100%)	0/1	1/1 (100%)
	M8C	ND[4]	ND[4]	ND[4]
01-99	M8A	3/5 (60%)	2/5 (40%)	ND[4]
	M8C	ND[4]	ND[4]	ND[4]
	M8C	ND[4]	ND[4]	ND[4]
02-99	M8A	ND[4]	ND[4]	ND[4]
	M8B	ND[4]	ND[4]	ND[4]
	M8C	0/1	0/1	0/1
03-99	M8A	1/5 (20%)	0/5	0/1

[1] *Systemic bacteria isolated from kidney smear inocula were* Flavobacterium psychrophilum *and aeromonad-pseudomonad (APS) types.*

[2] *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

[3] *These isolates were tested by the rapid slide agglutination test.*

[4] *Indicates not done (ND) because no moribund or fresh-dead fish were available.*

Appendix Table A-5. Proportions and prevalence (%) of bacterial agents isolated from moribund or fresh-dead 98 brood year Priest Rapids fall chinook salmon, released as subyearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
03-99	O2A	0/5	2/5 (40%)	0/5
	O2B	0/5	3/5 (60%)	0/5
	O3A	0/5	5/5 (100%)	0/5
04-99	M1B	0/1	0/1	1/1 (100%)[3]
	M2B	1/2 (50%)	0/2	2/2 (100%)
	M3B	0/3	1/3 (33.3%)	0/3

[1] *The only systemic bacteria isolated from kidney smear inocula were* Flavobacterium psychrophilum *and aeromonad-pseudomonad (APS) types.*

[2] *These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

[3] *Determined to be* F. psychrophilum *by the rapid slide agglutination test.*

Appendix Table A-6. Proportions and prevalence (%) of bacterial agents isolated from moribund or fresh-dead 97 brood year Umatilla spring chinook salmon, released as yearlings, during monthly juvenile fish health monitoring. Unless indicated otherwise, the prevalence was 0%.

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
06-98	O5A	0/4	3/4 (75%)	0/3
07-98	O5A	0/5	0/5	0/5
08-98	O4A	0/3	0/1	0/1
	O4B	0/1	0/1	ND[4]
	O5A	0/2	0/2	0/2
	O5B	ND[4]	ND[4]	ND[4]
	M2A	2/5 (40%)	0/5	0/2
	M2B	0/3	0/3	0/1
	M2C	0/3	0/3	ND[4]
09-98	O4A	0/5	0/5	ND[4]
	O4B	2/4 (50%)[3]	0/4	ND[4]
	O5A	0/3	0/3	ND[4]
	O5B	0/4	0/4	ND[4]
	M2A	0/5	0/5	0/2
	M2B	0/1	0/1	0/1
	M2C	0/4	0/4	ND[4]
10-98	O4A	0/1	0/1	0/1
	O4B	ND[4]	ND[4]	ND[4]
	O5A	0/1	0/1	0/1
	O5B	0/2	0/2	0/1
	M2A	0/3	1/3 (33.3%)	0/2
	M2B	0/3	1/3 (33.3%)	0/1
	M2C	0/1	0/1	ND[4]
11-98	O5A	0/5	2/5 (40%)	ND[4]
	O5B	0/5	1/5 (20%)	0/2
	M2A	0/1	0/1	ND[4]
	M2B	0/3	0/3	0/2
	M2C	0/1	0/1	ND[4]

[1]*The only systemic bacteria isolated from kidney smear inocula were* Flavobacterium psychrophilum *and aeromonad-pseudomonad (APS) types.*

[2]*These were determined to be significant only if yellow pigmented colonies were the prevalent type on smears made from gill inocula.*

[3]*Determined to be* F. psychrophilum *by the rapid slide agglutination test.*

[4]*Indicates not done (ND) because no moribund or fresh-dead fish were available.*

Appendix Table A-6 (continued)

Date sampled	Raceway	Systemic bacteria[1]		Gill bacteria[2]
		F. psychrophilum	APS	
12-98	O5A	0/1	0/1	0/1
	O5B	ND[4]	ND[4]	ND[4]
	M2A	0/5	0/5	1/5 (20%)
	M2B	0/4	0/4	0/2
	M2C	0/1	0/1	ND[4]

Appendix Table A-7. Number of 98 brood year Priest Rapids fall chinook salmon juveniles, released as subyearlings, assayed by the DFAT for *Renibacterium salmoninarum* during monthly monitoring. Fish were sampled from Oregon raceways O2A, O2B, O3A and from Michigan raceways M1B, M2B, and M3B, all were negative.

Date sampled	O2A[1]	O2B[1]	O2B[2]	O3A[1]	M1B[1]	M1B[2]	M2B[1]	M2B[2]	M3B[1]	M3B[2]
03-99	5	5	5	5						
04-99					1	5	2	5	3	5

[1]*Moribund or fresh-dead fish.*
[2]*Normal, healthy appearing fish.*

Appendix Table A-8. DFAT results and ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 97 brood year Umatilla River spring chinook salmon juveniles, released as yearlings, sampled during monthly monitoring from Oregon series O4 (A and B), O5 (A and B), and Michigan series M2 (A, B, and C).

	ELISA OD_{405}										
Date sampled	O4A[2]	O4B[2]	O4B[3]	O5A[2]	O5A[3]	O5B[2]	O5B[3]	M2A[2]	M2B[2]	M2C[2]	M2C[3]
6-98				0/4[4]	0/5[4]						
7-98				0/2[4]	.009						
				.007	.011						
				.008	.012						
				.011	.014						
					.023						
8-98	.013	.011					.008	.009		ND[5]	.006
	.017						.010	.015			.008
	.019						.010				.012
							.011				.010
							.015				.009

[1] *Individual kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 or 1:15 weight/volume dilution for the ELISA.*

[2] *Moribund or fresh-dead fish.*

[3] *Normal, healthy appearing fish.*

[4] *Examined by the DFAT because of the small fish size.*

[5] *Indicates not done (ND) because no moribund or fresh-dead fish were available*

Appendix Table A-8 (continued).

Date Sampled	ELISA OD_{405}										
	O4A[2]	O4B[2]	O4B[3]	O5A[2]	O5A[3]	O5B[2]	O5B[3]	M2A[2]	M2B[2]	M2C[2]	M2C[3]
9-98	0/1[4]	0/2[4]	.006	0/2[4]		.011	.006	0/1[4]	0/1[4]	.014	.006
	.007	.014	.008	.016		.013	.007	.008		.019	.009
	.008	.027	.009				.009	.008		.026	.011
	.009		.009				.013	.012			.013
	.014		.015				.014	.024			.016
10-98	.021	ND[5]	.014	.021		.024	.024	.010	.021	.019	.025
			.015			.030	.026	.012	.026		.027
			.015				.027	.043	.031		.028
			.025				.030				.032
			.044				.031				.032
11-98				.014		0/1[4]	.013	0/1[4]	0/1[4]	0/1[4]	.024
				.015		.015	.014		.027		.019
				.016		.018	.017		.028		.015
				.023		.018	.017				.021
				.026		.022	.024				.031
12-98				.035		ND[5]	.005	.017	.011	.009	.023
							.009	.022	.014		.025
							.024	.023	.014		.037
							.025	.041	.042		.038
							.041	.051			.047

Appendix Table A-9. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 30 Priest Rapids 98 brood year fall chinook salmon juveniles per raceway, released as subyearlings from Michigan series M2(A and B), M3(A and B), and M4(A and B). Means and ranges for each raceway are shown below the 30 individual sample readings. All raceways were sampled on 05-10-99 at a mean body weight of 5.7 gms/fish.

Sample Number	ELISA OD_{405}		
	M2B	M3B	M4B
1	.006	.007	.005
2	.007	.008	.006
3	.007	.008	.007
4	.009	.009	.008
5	.010	.010	.008
6	.010	.011	.009
7	.011	.011	.009
8	.011	.012	.010
9	.011	.012	.010
10	.013	.013	.011
11	.013	.014	.011
12	.014	.014	.011
13	.015	.014	.011
14	.015	.014	.012
15	.015	.015	.013
16	.015	.016	.013
17	.015	.017	.013
18	.016	.017	.013
19	.016	.017	.014
20	.017	.018	.014
21	.017	.019	.015
22	.017	.019	.015
23	.018	.020	.017
24	.018	.021	.018
25	.018	.022	.018
26	.019	.023	.018
27	.020	.024	.020
28	.021	.025	.025
29	.023	.027	.028
30	.024	.031	.029
Mean	0.015	0.016	0.014
Range	.006-.024	.007-.031	.005-.029

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:15 weight/volume dilution for ELISA.*

Appendix Table A-10. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from 30 Umatilla River 97 brood year spring chinook salmon juveniles from Oregon series O5 (A and B) and Michigan series M2 (A, B, and C). Means and ranges for each raceway are shown below the 30 individual sample readings. Fish were sampled on 01-21-99 at a mean body weight of 31.3 gms/fish.

Sample number	ELISA OD_{405}				
	O5A	O5B	M2A	M2B	M2C
01	.012	.005	.006	.007	.005
02	.013	.008	.009	.007	.006
03	.014	.009	.009	.007	.009
04	.014	.009	.009	.010	.009
05	.014	.009	.009	.010	.010
06	.015	.010	.012	.010	.010
07	.016	.010	.012	.011	.011
08	.017	.011	.013	.012	.011
09	.018	.011	.013	.012	.011
10	.019	.012	.013	.014	.012
11	.019	.012	.014	.015	.013
12	.019	.012	.014	.015	.013
13	.020	.012	.016	.016	.014
14	.020	.013	.016	.016	.015
15	.020	.013	.017	.017	.015
16	.020	.014	.018	.017	.015
17	.021	.014	.018	.017	.017
18	.021	.015	.018	.018	.017
19	.022	.016	.018	.018	.017
20	.022	.016	.018	.018	.017
21	.023	.016	.018	.019	.018
22	.026	.018	.018	.019	.019
23	.026	.018	.019	.021	.019
24	.026	.018	.020	.022	.020
25	.026	.019	.020	.022	.020
26	.029	.019	.022	.023	.021
27	.034	.019	.024	.024	.021
28	.035	.021	.026	.025	.022
29	.044	.022	.036	.029	.027
30	.046	.026	.040	.032	.028
Mean	.022	.014	.017	.017	.015
Range	.012-.046	.005-.026	.006-.040	.007-.032	.005-.028

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*

Appendix Table A-11. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) per pond of Umatilla River 97 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-08-99 and were reared at Umatilla Hatchery.

Pond 1		Pond 2	
Mt/Mb[2]	He[3]	Mt/Mb[2]	He[3]
.009	.015	.012	.010
.013	.016	.012	.017
.014	.018	.014	.019
.020	.018	.014	.021
.042	.019	.015	.042

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*
[2] *Moribund or fresh-dead fish.*
[3] *Normal, healthy appearing fish.*

Appendix Table A-12. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 97 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 03-08-99 and were reared at Little White Salmon NFH.

Pond 4	
Mt/Mb[2]	He[3]
.024	.023
.032	.026
.043	.030
.169	.034
3.028	.034

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*
[2] *Moribund or fresh-dead fish.*
[3] *Normal, healthy appearing fish.*

Appendix Table A-13. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five grab-sampled (He) Carson 97 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 04-07-99 and were reared at Carson NFH. Moribund or fresh-dead fish were not available for sampling.

Pond 2
He[2]
.015
.029
.033
.034
.035

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA*
[2] *Normal, healthy appearing fish.*

Appendix Table A-14. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from one moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) Carson 97 brood year spring chinook salmon juveniles, released as yearlings, from Imeques C-mem-ini-kem acclimation ponds. Fish were sampled on 04-07-99 and were reared at Little White Salmon NFH.

Pond 3	
Mt/Mb[2]	He[3]
.026	.031
	.033
	.046
	.073
	.794

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*
[2] *Moribund or fresh-dead fish.*
[3] *Normal, healthy appearing fish.*

Appendix Table A-15. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) per pond of Bonneville 97 brood year fall chinook salmon juveniles, released as yearlings, from Thornhollow acclimation ponds. Fish were sampled on 03-11-99 and were reared at Bonneville Hatchery.

Pond 1		Pond 2	
Mt/Mb[2]	He[3]	Mt/Mb[2]	He[3]
.010	.016	.012	.010
.085	.020	.014	.011
2.871	.065	2.724	.013
2.960	.526	2.856	.018
2.978	3.021	2.956	.018

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*
[2] *Moribund or fresh-dead fish.*
[3] *Normal, healthy appearing fish.*

Appendix Table A-16. Preliberation ELISA readings (OD_{405}) for *Renibacterium salmoninarum* of kidney samples[1] from five moribund/fresh-dead (Mt/Mb) and five grab-sampled (He) per pond of Bonneville 97 brood year fall chinook salmon juveniles, released as yearlings, from Thornhollow acclimation ponds. Fish were sampled on 04-07-99 and were reared at Bonneville Hatchery.

Pond 1		Pond 2	
Mt/Mb[2]	He[3]	Mt/Mb[2]	He[3]
.040	.010	.031	.023
2.737	.012	.040	.030
3.003	.016	.068	.033
3.114	.025	3.308	.034
3.485	.388	3.462	.049

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:7 weight/volume dilution for ELISA.*
[2] *Moribund or fresh-dead fish.*
[3] *Normal, healthy appearing fish.*

Appendix Table A-17. Proportions and prevalence (%) of infectious hematopoietic necrosis virus (IHNV) detected in ovarian fluid (OF) and milt (M) samples, and three-fish pooled pyloric caeca/kidney/spleen (PKS) samples from Umatilla summer steelhead spawned in 1999 at Minthorn adult facility for Umatilla Hatchery 99 brood year production.

Date sampled	Proportion and prevalence (%) of IHNV		
	OF	M	PKS
04-07-99	0/12 (0%)	0/12 (0%)	0/4 (0%)
04-15-99	0/6 (0%)	0/6 (0%)	0/2 (0%)
04-22-99	0/1 (0%)	0/1 (0%)	0/1 (0%)
04-29-99	2/7 (28.5%)[1]	0/7 (0%)	1/3 (33.3%)
05-05-99	0/2 (0%)	0/2 (0%)	0/1 (0%)
05-13-99	0/4 (0%)	0/4 (0%)	0/2 (0%)
05-18-99	0/6 (0%)	0/4 (0%)	0/2 (0%)
05-27-99	1/3 (33.3%)	0/3 (0%)	1/1 (100%)
Total	3/41 (7.3%)	0/39 (0%)	2/16 (12.5%)

[1]One of two IHNV isolates from this group was determined to be a Type 2 strain by the indirect fluorescent antibody (IFAT) test using strain-specific 105B monoclonal antibody.

Appendix Table A-18. Date and number of samples for culturable viruses[1] from Priest Rapids fall chinook salmon spawned in 1998 for Umatilla Hatchery 98 brood year production. Samples for culturable viruses were taken as five-fish pooled ovarian fluid (OF) and kidney/spleen (KS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date sampled	OF	KS
11-16-98	12	12

[1]*These analyses were done and data provided by Washington Department of Fish & Wildlife (WDFW) Fish Health personnel.*

Appendix Table A-19. ELISA results for *Renibacterium salmoninarum* of 79 kidney samples[1] from Umatilla fall chinook salmon female adults spawned at Three Mile Dam adult facility in 1998 for Bonneville 98 brood year production.

Spawn Date	Total Sampled	Number and percent within selected ELISA OD_{405} Range: 0.0 to 0.099	0.100 to 0.199	0.200 to 0.399
11-03-98				
Female	9	9 (100%)	0	0
11-09-98				
Female	11	11 (100%)	0	0
11-12-98				
Female	17	17 (100%)	0	0
11-16-98				
Female	23	23 (100%)	0	0
11-20-98				
Female	10	10 (100%)	0	0
11-24-98				
Female	9	9 (100%)	0	0
Totals				
Female	79	79 (100%)	0	0

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-20. ELISA results for *Renibacterium salmoninarum* of kidney samples[1] from 10 Umatilla fall chinook salmon adult mortalities in 1998 at Three Mile Dam adult facility.

Spawn Date	Total Sampled	Number and percent within selected ELISA OD_{405} Ranges: 0.0 to 0.099	0.100 to 0.199	0.200 to 0.399
11-09-98				
Female	1	1 (100%)	0	0
Male	1	1 (100%)	0	0
11-12-98				
Female	0	0	0	0
Male	1	1 (100%)		
11-16-98				
Female	2	2 (100%)	0	0
Male	1	1 (100%)		
11-20-98				
Female	0	0	0	0
Male	1	0	1 (100%)	0
11-24-98				
Female	0	0	0	0
Male	3	3 (100%)	0	0
Totals				
Female	3	3 (100%)	0	0
Male	7	6 (85.7%)	1 (14.3%)	0

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-21. Date and number of samples for culturable viruses from Umatilla fall chinook salmon spawned at Three Mile Dam adult facility in 1998 for Bonneville 98 brood year production. Culturable viruses were sampled for as individual ovarian fluid (OF) and four-fish pooled pyloric caeca/kidney/spleen (PKS) samples. All samples were negative for infectious hematopoietic necrosis virus and other culturable viruses.

Date Sampled	OF	PKS
11-03-98	8	2
11-09-98	8	3
11-12-98	18	5
11-16-98	20	6
11-20-98	10	0
11-24-98	8	0

Appendix Table A-22. ELISA results for *Renibacterium salmoninarum* of 382 kidney samples[1] from Umatilla River spring chinook salmon male and female adults spawned at South Fork Walla Walla adult facility for Umatilla Hatchery 99 brood year production.

		Number and percent within selected ELISA OD_{405} Ranges		
Spawn Date	Total Sampled	0.0 to 0.099	0.100 to 0.199	0.200 to 0.399
08-24-99				
Female	24	24 (100%)	0	0
Male	8	8 (100%)	0	0
08-31-99				
Female	134	133 (99.3%)	1 (0.7%)	0
Male	54	54 (100%)	0	0
09-07-99				
Female	109	107 (98.2%)	1 (0.9%)	1 (0.9%)
Male	39	39 (100%)	0	0
09-14-99				
Female	9	8 (88.9%)	1 (11.1%)	0
Male	5	5 (100%)	0	0
Totals				
Female	276	272 (98.5%)	3 (1.1%)	1 (0.4%)
Male	106	106 (100.00%)	0	0

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-23. ELISA results for *Renibacterium salmoninarum* of kidney samples[1] from 28 Umatilla River spring chinook salmon adult mortalities in 1999 at South Fork Walla Walla adult facility for Umatilla Hatchery 99 brood year production.

		Number and percent within selected ELISA OD_{405} Ranges		
Spawn Date	Total Sampled	0.0 to 0.099	0.100 to 0.199	0.200 to 0.399
08-17-99				
Female	4	4 (100%)	0	0
Male	1	1 (100%)	0	0
08-31-99				
Female	5	5 (100%)	0	0
Male	2	2 (100%)	0	0
09-07-99				
Female	3	3 (100%)	0	0
Male	9	9 (100%)	0	0
09-14-99				
Female	4	4 (100%)	0	0
Male	0	0	0	0
Totals				
Female	16	16 (100.00%)	0	0
Male	12	12 (100.00%)	0	0

[1] *Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*

Appendix Table A-24. Proportions and prevalence (%) of infectious hematopoietic necrosis virus (IHNV) detected in individual ovarian fluid (OF) and four-fish pools of pyloric caeca/kidney/spleen (PKS) samples from Umatilla River spring chinook spawned in 1999 at the South Fork Walla Walla adult facility for Umatilla Hatchery 99 brood year production.

Date sampled	Proportion and prevalence (%) of IHNV	
	OF	PKS
08-24-99	2/20 (10%)[1]	2/6 (33.3%)
08-31-99	2/20 (10%)	2/5 (40%)
09-07-99	16/20 (80%)	4/4 (100%)
09-14-99	9/9 (100%)	ND
Total	29/69 (42%)	8/15 (53.3%)

[1]*One of two IHNV isolates from this group was determined to be a Type 2 strain in the indirect fluorescent antibody (IFAT) test using strain-specific 105B monoclonal antibody.*

Appendix Table A-25. ELISA results for *Renibacterium salmoninarum* of kidney samples[1] from 237 adult spring chinook salmon male and female adults spawned in 1999 at South Fork Walla Walla adult facility for Umatilla Hatchery 99 brood year production. These fish were sampled between August 24 and September 14, 1999 and were identified by origin, either Umatilla Hatchery or Other Origin, using coded wire tag recovery data. All fish were identified as 95 and 96 brood year fish. For Umatilla Hatchery, the type of rearing raceway, Oregon or Michigan, is indicated.

			Number and percent within selected ELISA OD_{405} Ranges		
Spawn Date		Total Sampled	0.0 to 0.099	0.100 to 0.199	0.200 to 0.399
Oregon	95	216	221 (99.5%)	0	1 (0.5%)
	96	6	6 (100%)	0	0
Michigan	95	N/A	N/A	N/A	N/A
	96	14	14 (100%)	0	0
Other Origin	96	1[2]	1 (100%)	0	0

[1]*Kidney samples were homogenized in PBS-Tween 20 buffer at a 1:3 weight/volume dilution for ELISA.*
[2]*This fish was reared at Little White Salmon NFH (USFWS Washington).*